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Quarterly Journal
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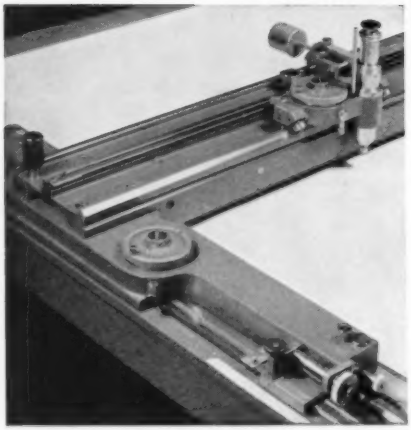

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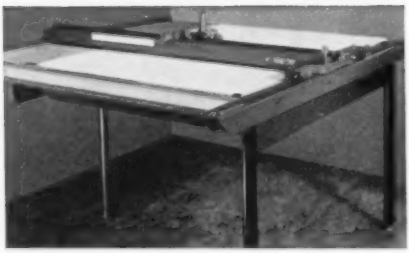

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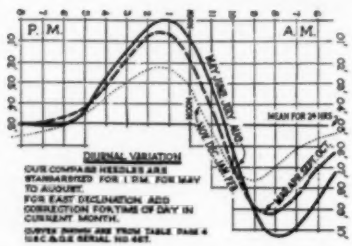

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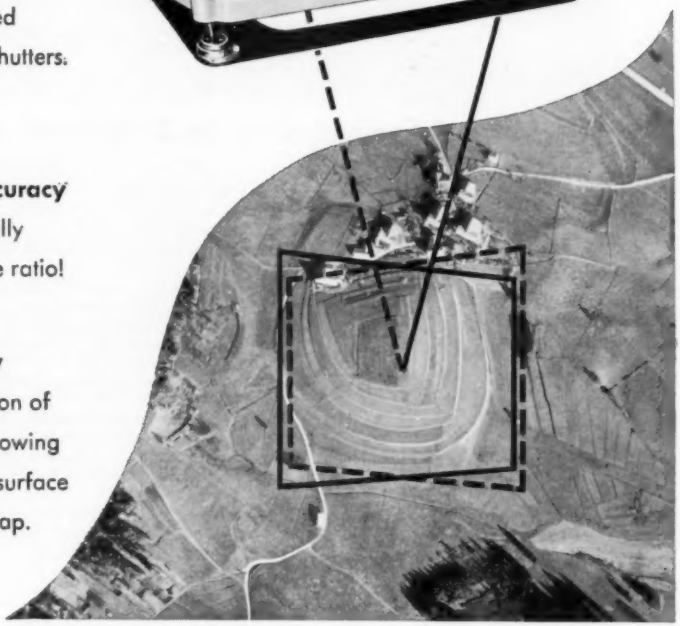

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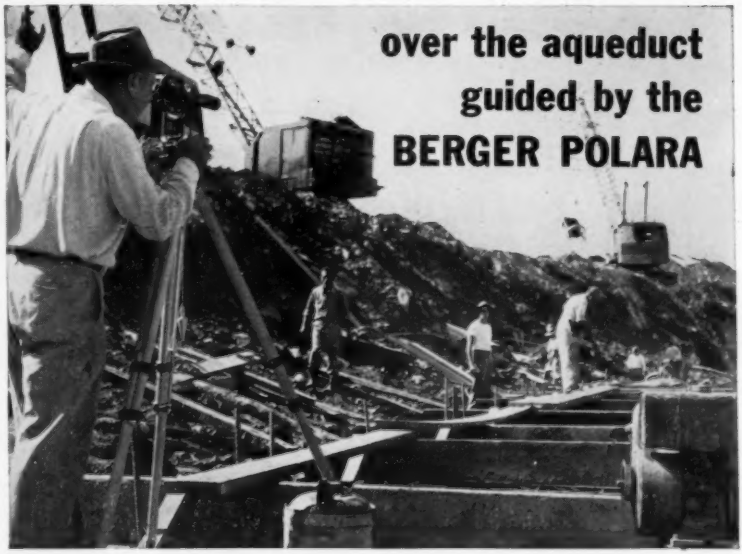

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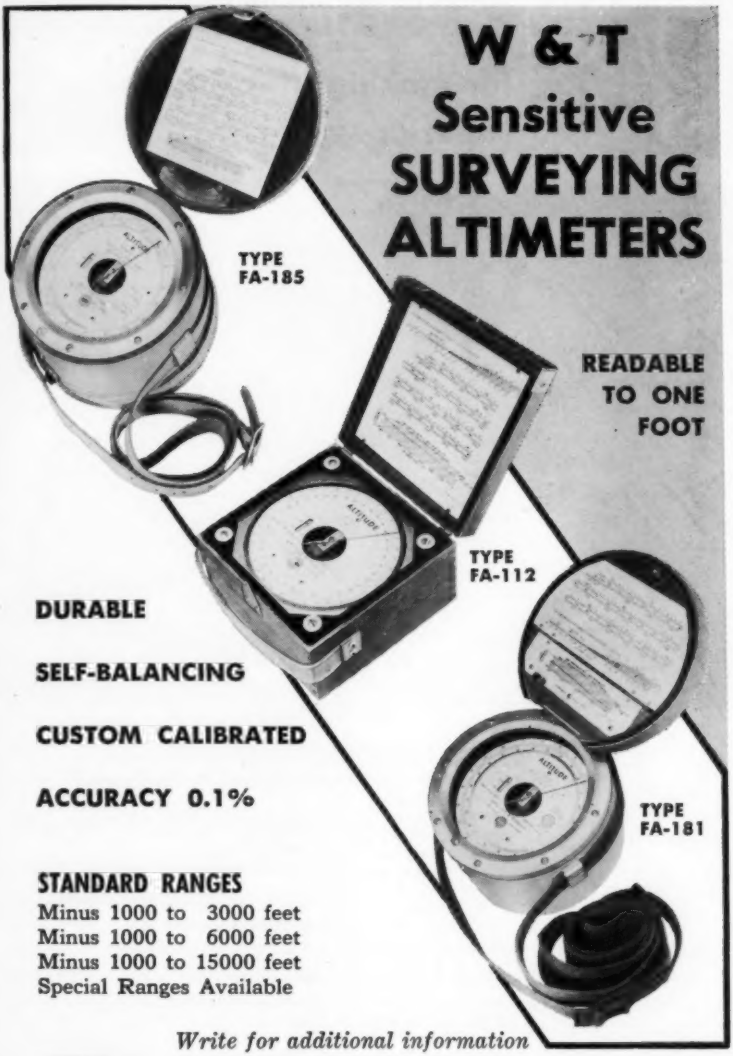

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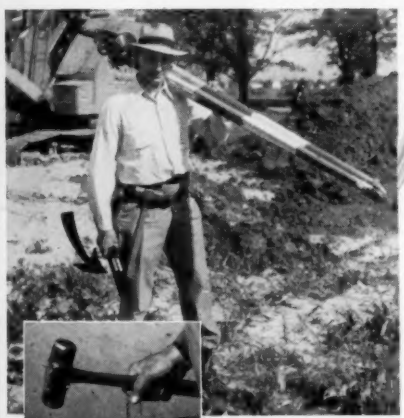

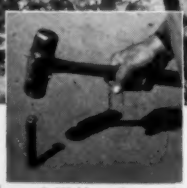

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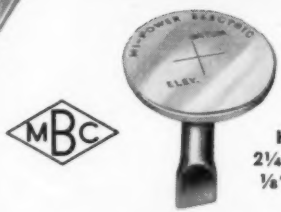

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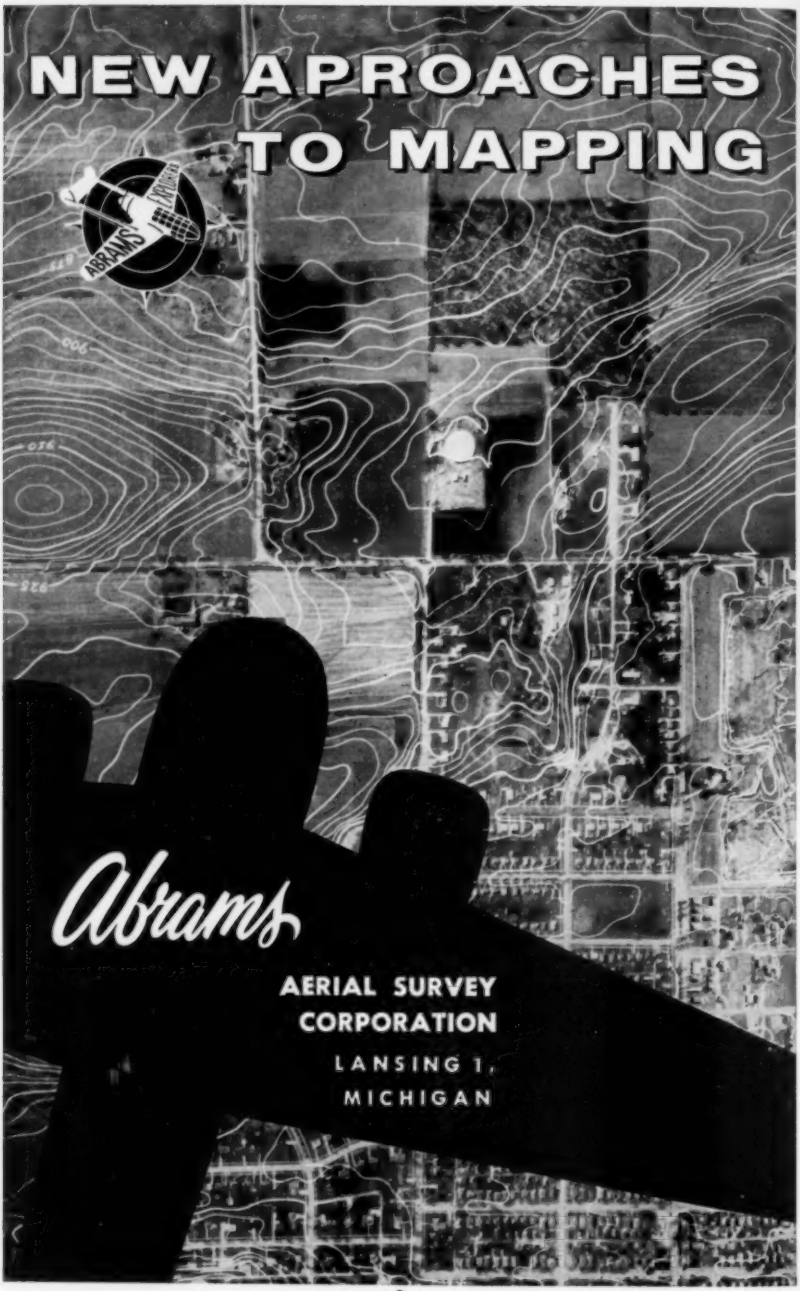
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EVERY maritime nation recognizes the need for surveying and charting its coastal regions in the interest of waterborne commerce. Without adequate charts, free and unrestricted intercourse by water would be impossible and the harbors would be as effectively closed to the commerce of the world as though blockaded by an enemy fleet. Charting the coastal areas of a nation, therefore, stands high on the list of obligations for the promotion of the comity of nations. In the commerce clause of our Constitution that obligation is fully recognized in the provision that "Congress shall have the power to regulate commerce with foreign nations and among the several States." As an incident of that power, there is the concomitant power to control and protect navigation, which necessarily includes the preparation and publication of nautical charts.

This national obligation and constitutional power was given force and effect early in the history of our country, when President Jefferson, on February 10, 1807, obtained authority from Congress "to cause a survey to be taken of the coasts of the United States, . . ." This was the inception of what is today the Coast and Geodetic Survey, and it is this historic event that is being commemorated in this year 1957—150 years later.

During the century and a half of the Survey's existence, the nautical chart has been developed to a remarkably high degree of accuracy and usefulness. In assessing this development, cognizance must be taken of the fact that what had previously been called a chart was largely the result of exploration or of limited surveys, and was generally the work of individual effort and private undertaking. The Portolanos of the 14th century, the Cosa Chart of 1500, and the Atlantic Neptune Charts of the late 18th century are all examples of this exploratory period. These, like all of the early charts, suffered from two great defects—the want of detailed surveys, and the lack of a rigid system of connection between the various ports.

Not until the early part of the 19th century did governments begin to recognize the wisdom of systematically charting their coastal waters as a necessary prelude to their commercial intercourse with other nations. It marked a new era in chart making and was the beginning of the accurate chart of today.

The navigator whose responsibility is the safety of lives and cargo must have at all times a full and complete knowledge of the coast, the depths of the water and character of the sea bottom near it, the locations of reefs, shoals, and other dangers to navigation, the rise and fall of the tides, the direction and strength of sea currents, and the behavior of the earth's magnetism in areas which must be navigated. Nautical charts furnish such information.

Unlike many other cartographic efforts, the nautical chart is intended for serious use in the solution of navigational problems; hence, all the rules of engineering must be meticulously observed in its preparation. In viewing the finished chart, we are often prone to lose sight of the vast amount of scientific data and the professional skill that go into its making. The chart is the end product of many field operations—triangulation, topography, hydrography, tides and currents, and geomagnetism—and the office operations of compilation, reproduction, and maintenance. Progressive improvement in the chart has therefore, in the main, been coextensive with the development of surveying techniques, including instrumentation and equipment.

A GEODETIC BASE FOR CHARTING

Good and reliable charts can be made

FIGURE 1.—Ferdinand R. Hassler, the first Superintendent of the Coast Survey.

only from correct surveys. No one appreciated this more than Professor Hassler, the Swiss scientist who was entrusted with the important task of directing the Survey of the Coast. (Fig. 1.) Hassler knew that so vast an undertaking, if it was to have a lasting value, could not be attacked as a problem in ordinary surveying; nor were astronomic observations alone the answer to the accurate charting of a country. Instead, the work was to be based upon geodetic principles in which the size and shape of the earth were to be taken into account and all observations and computations were to be defined in terms of a single geodetic datum. Only by this geodetic process could full coordination be obtained between adjacent charts and between charts in different localities. This was Hassler's great contribution. From the beginning he insisted on a strong system of triangulation as the backbone for all the harbor and coastal surveys, but the need for this was not so obvious to others, and as a result Hassler was subjected to much humiliating criticism. His scientific approach nevertheless prevailed, and this tradition of accuracy which he inaugurated has been steadfastly maintained through a century and a half of progressively increased activity. Had he planned to meet only the needs of his time, he would have effected but a negligible saving, and his work would have had to be done over at greater expense in later years. Instead, the triangulation work of that period meets modern requirements and forms part of the permanent primary network of the country.

Triangulation is to the nautical chart what the steel framework is to a building—it gives it rigidity and knits together all portions into a harmonious whole. Without this framework of control, our charts would be subject to the same deficiency that characterized the charts of the Colonial period, as exemplified by the Atlantic Neptune of Des Barres. (Fig. 2.) Continuous triangulation has now been extended over the whole of the United States through Canada and Alaska to the Bering Strait—all based on the North American datum of 1927.

Even the distant, offshore islands in the Bering Sea have recently been connected for the first time with the triangulation network on the mainland of Alaska by a system of trilateration (a measurement of the sides of a triangle, as distinguished from triangulation in which the angles are measured), using electronic methods, the longest distance measured being 501 statute miles. (Fig. 3.) The successful completion of this project furnishes a control net for hydrographic surveys from which accurate charting of this vast, strategic area can proceed with minimum danger to men and ships.

Improved instruments and equipment have accelerated the progress of triangulation work. When Hassler started his work in 1816, he had a special carriage built to transport his great, cumbersome, 24-inch-circle theodolite. The theodolites used today are 9-inch and 5-inch and can be back-packed up mountain peaks by one man. Night observing on electric signal lamps and the portable steel tower have contributed to this progress. (Fig. 4.)

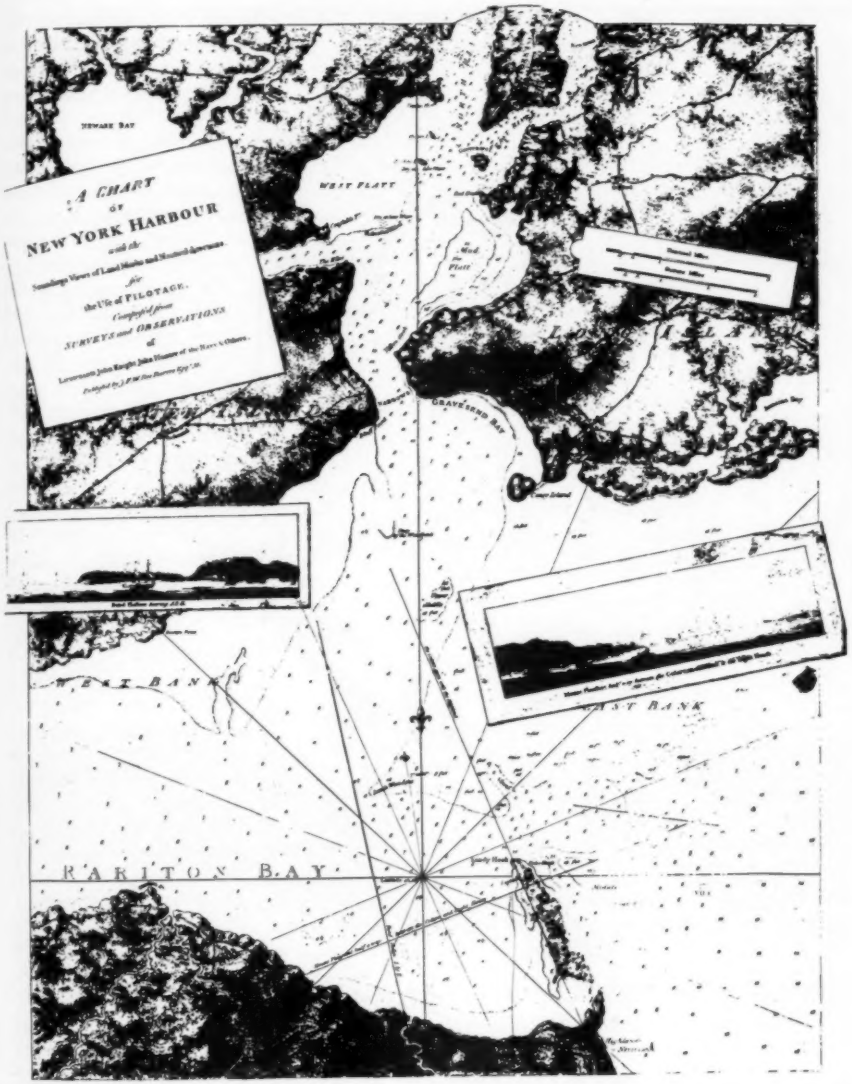

FIGURE 2.—Chart of New York Harbor from the Atlantic Neptune, an atlas of charts compiled by Des Barres, 1775 to 1781.

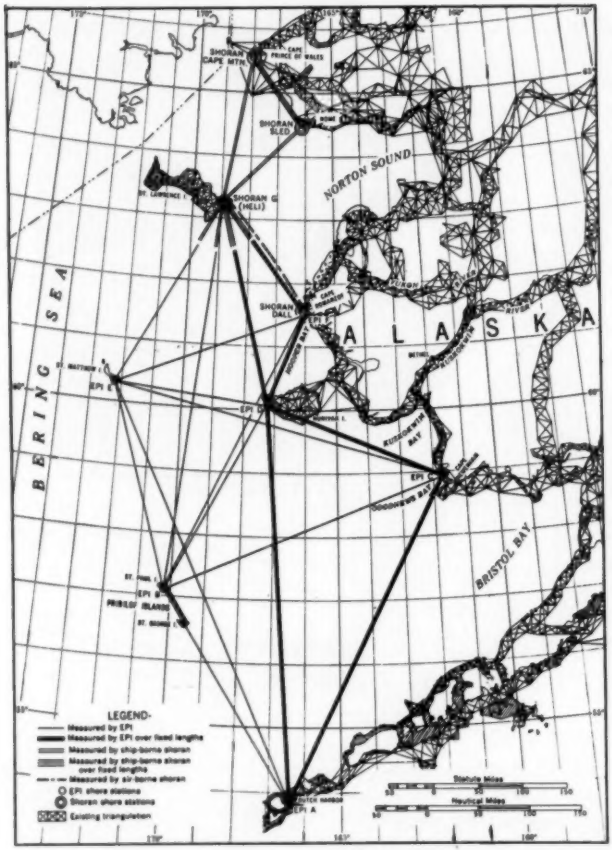

FIGURE 3.—In 1951, the distant, offshore islands in the Bering Sea were connected by trilateration to the Alaska triangulation. This put them for the first time on the same geodetic datum as the United States.

THE MISSION OF PHOTOGRAMMETRY

An important feature of the nautical chart is the land area, with its characteristic shore forms, its landmarks, and elevations and depressions. To obtain these data, topographic surveys are made of the area adjacent to the coastline, and all details of value to the navigator are delineated and indicated on the chart. For mapping from the ground, the planetable (Fig. 5) is still the most satisfactory instrument because the surveyor maps as he surveys, using the terrain as a model. With proper precautions, a remarkable degree of accuracy is attainable by this method of surveying.

Today, ground topographic methods are rapidly giving way to the more economical and more expeditious method of mapping from the air. Aerial photogrammetry marks the greatest advance in topographic mapping since the prototype of the modern planetable was developed by Johann Praetorius in 1590. The wealth of information and fullness of detail embraced in an aerial photographic survey cannot be matched by any other practicable method of surveying. The use of multilens aerial cameras—together with stereoscopic plotting equipment for reducing the photographs to map form—gave considerable impetus to the mapping of areas where difficult and inaccessible terrain could be bridged with a minimum of ground control. (Fig. 6.)

The advent of photogrammetry has had two salutary effects on the nautical chart: (1) It has increased the accuracy of the chart, particularly in areas difficult of access from the ground; and (2) it has brought within practicable scope the immediate revision of areas where natural or manmade changes have taken place—an important factor in safeguarding our sea-lanes.

HYDROGRAPHIC ADVANCES

The predominant feature of a nautical chart, and the most significant to the navigator, is the water area, for it is this area that his vessel must traverse. Hydrography, or the measurement of depth and the determination of position, is thus the principal ingredient of the chart. By it the navigator is guided into the safe lanes and can avoid the known dangers.

Developments in the science of hydrographic surveying, during the past three decades, have had a greater effect on the accuracy and usefulness of the nautical chart than the combined developments during the preceding hundred years. The old and well-known methods of sounding—the hand lead and line for shoal water (Fig. 7), and the wire-sounding machine for deep water—have given way to echo sounding, and electronic methods have superseded all previous less accurate methods of position determination.

Echo sounding is an outgrowth of the experimental work begun in 1912 for detecting the presence and nearness of ice-

FIGURE 4.—Portable steel tower used in triangulation work for overcoming interference due to the earth's curvature, forest growth, etc.

FIGURE 5.—Mapping an Alaskan coastline with the planetable. Aerial photogrammetry has largely superseded ground topographic methods.

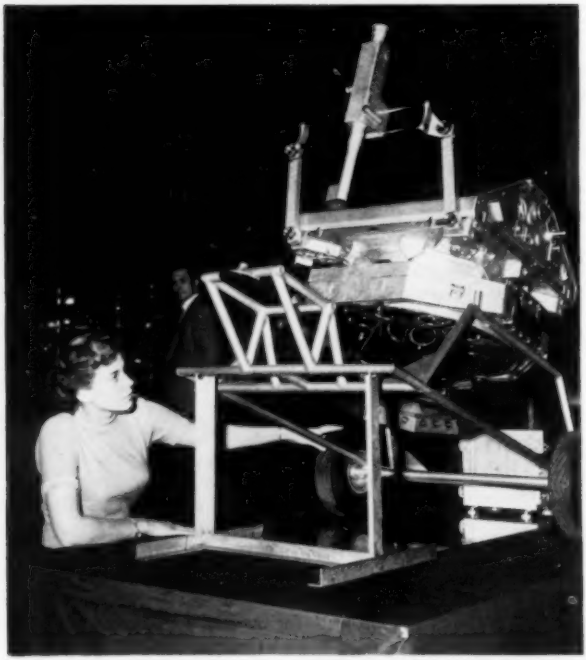

FIGURE 6.—A nine-lens aerial camera was designed in the Coast Survey for mapping in areas where difficult terrain necessitated the establishment of a minimum of ground control.

bergs, and of the submarine-detection devices developed during World War I. A sound impulse emanating from the survey vessel is reflected from the ocean bottom as an echo. The time elapsed for its receipt on the vessel affords a measure of the depth, if the velocity of sound in sea water is known. (The latter is dependent upon the existing physical properties of the water —temperature, salinity, and pressure—and is determined during the progress of the survey.) Echo-sounding equipment is designed to produce the sounds, receive the echoes, and translate the elapsed time intervals into depths and register them as instantaneous flashes on a graduated dial or record them on a sensitized paper in the form of a graphic profile. (Fig. 8).

Position determination in hydrographic surveying has undergone more radical changes during the span of the modern nautical chart than perhaps any other technique. For inshore surveys, sextant location from shore objects was always used, and is still in use today. For offshore position fixing, precise dead reckoning was developed together with refinements in celestial observations. But these still left much to be desired and an accurately coordinated offshore survey was the exception rather than the rule. The first major change occurred in the late 1920's with the development of a method known as Radio Acoustic Ranging which utilized underwater sound transmission and radio to determine the distance of the survey vessel from two or more known stations. Simultaneously, a buoy-control method was devised based on taut-wire measurements and sun azimuths.

World War II ushered in the electronic era. Shoran, a form of radar, was developed for strategic aerial bombing. This technique was adapted by the Coast and Geodetic Survey to the accurate location of a survey ship's position. Being a line-of-sight system, it is limited, under practical operating conditions, to distances of 50 to 75 miles. To extend these limits, a new electronic device was developed—the Electronic Position Indicator (EPI). This system combines the long-range characteristics of Loran with the distance-measuring features of Shoran, and makes possible the precise measurement of distances in excess of 300 miles. Both Shoran and EPI yield results within the limits of precision required in hydrographic surveys.

The acoustic and electronic methods have steadily pushed seaward the frontiers of accurate hydrographic surveys. They have made feasible the survey of the intricate patterns of our continental shelves and slopes with an accuracy and completeness undreamed of by the former methods, and thus have added to the safety of life and property at sea. The rapidity with which depths can be measured by echo sounding (a matter of seconds compared to the hour or more required by the older method) has made it possible to take thousands of soundings in areas where formerly only a few scattered ones were economically feasible. This has increased our sum total of geographic knowledge and has brought to light many heretofore unknown submarine features of major physiographic proportions.

FIGURE 7.—Depths were obtained with the leadline prior to the advent of echo sounding.

SCIENTIFIC CHART MAKING

It has already been noted that improvements in the nautical chart were in general coextensive with improvements in surveying techniques. With each accession of new data, resulting from surveying developments, the nautical chart improved in accuracy standards and in coverage. But the chart also developed in its own right cartographi-

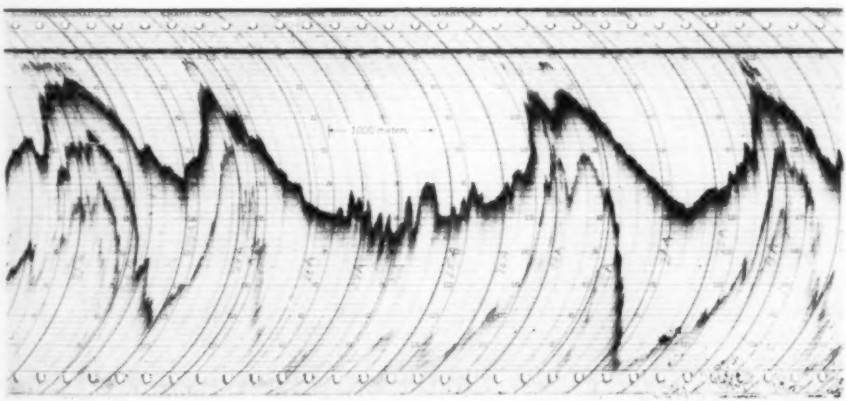

FIGURE 8.—While the survey ship is underway, the graphic recording type of echo sounder traces a continuous profile of the ocean bottom.

cally. Since publication of the early charts by the Coast Survey there has been a progression of improvements both in the character of the chart and in the methods of reproduction—all designed to enhance its value to the navigator.

Projection Base.—The base for any chart is the projection, that is, the systems of lines that represent the parallels of latitude and the meridians of longitude on the surface of the earth. Without this framework, the chart would lack the property that enables the navigator to plot his position readily and to lay down the ship's course with accuracy and ease. The Coast Survey uses the Mercator projection in all its nautical charting.

This great development in nautical cartography has come down to us from the middle of the 16th century when Gerhard Kremer (Mercator), the Flemish mathematician and cartographer, devised the projection which bears his name. This projection is fundamental in marine navigation. On it, and it alone, a straight line—the simplest of all lines—joining any two points determines the constant course which a navigator must steer in sailing between them. A ship sailing such a course is said to follow a *rhumb*. This unique property of the straight rhumb line is what gives the projection the universality it enjoys today.

Chart Compilation.—Chartmaking is a combination of the work of the compiler, who prepares the engineering drawing, and the engraver or lithographic artist, who translates the drawing into a finished product for quantity reproduction. A good survey does not necessarily result in a good chart. Chart compilation is a process of selection. The usefulness and accuracy of the chart depend not only upon the material entering into its construction, but also upon the critical appraisal of such material and upon the intelligence with which the essen-

FIGURE 9.—The first step in the compilation of a nautical chart is a review and appraisal of the field data in the light of existing data.

tials are portrayed. (Fig. 9.) While the chart must show everything the navigator might need, his eye must not be confused with unimportant details. The special and frequently adverse conditions under which charts are used on shipboard call for good judgment throughout their preparation. Even the names, notes, and symbols must be so placed that they can be easily and quickly read.

Chart Reproduction.—On the reproduction side, some notable improvements have been made in the chart since the early days of copper engraving and plate printing. The early charts of the Coast Survey were artistic masterpieces. Every line, every figure, and every letter was engraved by hand. The fineness of detail that was possible in copper engraving afforded the engraver an opportunity for artistic expression seldom equalled by any other method. These charts were all printed in black and white.

Photolithography paved the way for the introduction of colors and offset printing. Important navigational features could now be emphasized for better identification—for example, the coloring of buoys to correspond to their colors on the ground; the accentuation of lighted aids to navigation by using a color overprint; and the use of tints for the land and shoal-water areas. Each rotary, lithographic press in the Coast Survey is capable of printing from three to five thousand impressions an hour, as compared with the one-hundred-a-day maximum that was possible by the older method of printing directly from engraved copper plates.

FIGURE 10.—Cutting in details of chart on glass negative with specially designed engraving tool.

The greatest single contribution the Survey has made in the reproduction process has been the development of negative engraving (now commonly referred to as "scribing") around the turn of the century. (Fig. 10.) This technique was first used as a more economical means of revising nautical charts. Revisions were applied directly to the wet-plate glass negatives using the conventional engraving tools then in use. Later, entire nautical charts were reproduced by this method. The compilation manuscript was photographed on glass negatives and then coated with an emulsion that was pervious to light so as to afford the engraver a facsimile of the manuscript. In 1935, the first engraving tool was designed for specific use on glass negatives, and by 1940 all the basic instruments and tech-

niques had been perfected in the Bureau. Both glass and plastics are now used for negative engraving. The direction is toward complete conversion from drafting to scribing of final copy in both the chart production and reproduction stages, so as to realize all of the inherent quality and economy of the technique.

A NEW TYPE OF CHART

One direct impact of the developments in hydrographic techniques on the nautical chart has been the design of a new type of chart. The need for such a chart was signaled by the installation of echo-sounding apparatus on our naval and merchant vessels between the World Wars. It is axiomatic that the more faithfully the chart portrays the submarine relief, the greater will be its usefulness to the navigator. The answer was not found in an increase in the number of soundings charted; this was already a characteristic of the conventional type chart. What was called for was a method that would utilize to the fullest extent the wealth of submarine detail provided by modern hydrographic surveys and at the same time portray this detail in a simple and usable manner. The new type of chart was the result. (Fig. 11.)

In this chart, depth contours, which are equivalent to land contours on a topographic map, are given special emphasis. In the drawing of the contours, full use is made of all the soundings obtained on the hydrographic survey, since a depth contour represents an infinite number of soundings. Characteristic features of the ocean bottom are thus brought into prominence which were not readily discernible on the former type of chart where soundings only were primarily used. These delineated features are comparable to permanent landmarks and furnish the navigator, equipped with an echo sounder, a simple method for identifying his position and for shaping his course

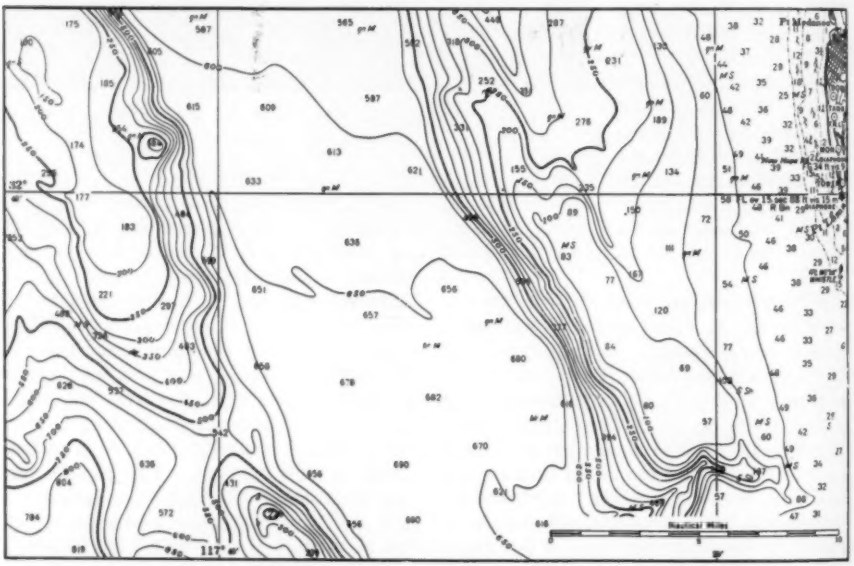

FIGURE 11.—Section of new type of nautical chart utilizing depth contours to emphasize submarine configurations which the navigator can use for locating his position. Formerly, charts were characterized by many soundings but few depth contours.

in advance so as to pass in close proximity to them.

Another significant innovation in nautical charting took place after World War II, with the establishment by the United States Coast Guard of a system of Loran stations along our coasts as an aid to navigation. Lines of position in this electronic system are families of hyperbolic curves that do not lend themselves to ready plotting by the navigator, as is the case with a circular system such as Shoran. To facilitate the navigator's use of this new aid, the Coast Survey, after experimenting with several methods of applying Loran information to the charts, has evolved a form that combines the hydrographic information with the Loran information without confusion, and in a manner that makes the chart of maximum use to the navigator. Loran charts now include coverage of the Atlantic, Gulf, and Pacific coasts.

FIGURE 12.—A fireproof vault houses some 17,000 topographic and hydrographic surveys that are used for keeping nautical charts current. The earliest survey dates back to 1834.

KEEPING CHARTS CURRENT

In one respect, the nautical chart has no exact counterpart in any other branch of cartography—it does not enjoy finality. It must be changed to reflect the activities of both man and nature. Breakwaters and jetties are built, channels and harbors dredged, tide flats filled and manufacturing plants and terminal facilities erected on them, and new aids to navigation are established and existing ones shifted.

The coastal region is the zone where two great physical provinces meet—the land and the sea—and where changes often take place with great rapidity. Ocean waves and currents are constantly taking material from one place and depositing it in another; rivers empty vast quantities of sediment near their mouths to build out the coastline and change the underwater configuration; in times of storm, barrier beaches are often broken through to form navigable inlets of a temporary or permanent nature; and bars and channels shift, new shoals form, and old ones disappear. The safety of navigation depends upon an accurate representation of all these changes on the published chart. (Fig. 12.)

Charts in some localities must be revised frequently to give an up-to-date picture of existing conditions, and to avoid early obsolescence. The New York Harbor chart,

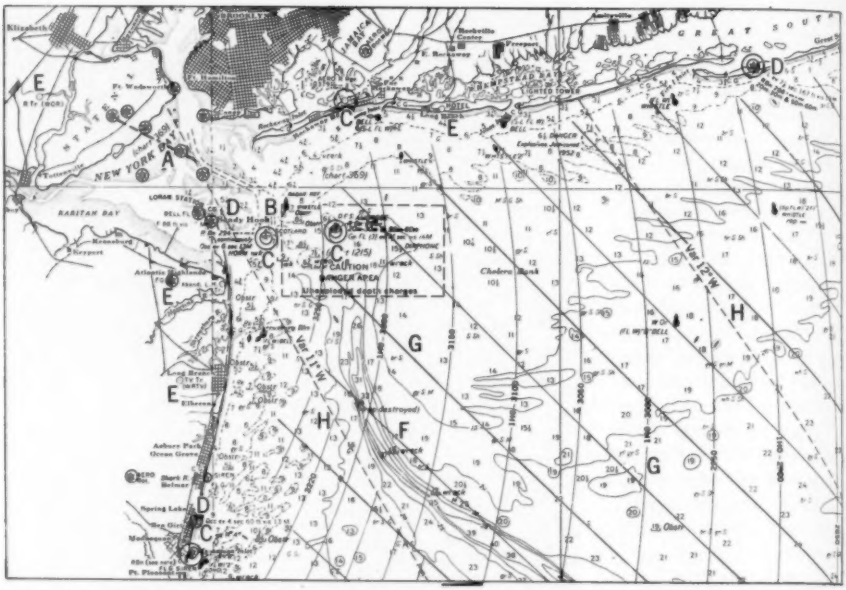

FIGURE 13.—Section of Chart 1108 (reduced) showing aids to navigation available to the navigator in leaving or approaching New York Harbor. Tints are used to accentuate the land area and the shoal-water areas.

for example, is revised about three times a year. A program of hand-correction is followed so that charts distributed are corrected to date of issue to show newly discovered dangers and all important navigational changes. During the year 1956, eight million hand-corrections were made. Sometimes the presses are even stopped to apply an important correction to the printing plate.

From here on, the navigator is on his own and must bring his chart up to date by scanning the weekly *Notices to Mariners* and other special publications issued for his benefit. The locations of outstanding dangers, newly discovered, are furnished him by radio. The Government thus makes every effort to keep the navigator fully informed of vital changes in the chart.

NAVIGATION WITH SAFETY AND ASSURANCE

In contrast to the early charts, it is of interest to examine a modern chart and to note the variety of data it provides the navigator for identifying his position at all times, day and night. Figure 13 is a section of Coast and Geodetic Survey Chart No. 1108, Approaches to New York Harbor. (Tints and colors—not shown in the illustration—to accentuate the land topography, shoal-water areas, depth contours, etc., provide him with additional cartographic aids.)

At *A*, he has a range for a line of position through Ambrose Channel.

At *B*, he has a danger warning and channel marker—buoy with radar reflector by day, and light of fixed characteristics by night.

At *C*, he has radio beacons on the lightships and on shore for obtaining bearings by radio compass from the vessel.

At *D*, he has the height and visibility of lights for determining position.

At *E*, he has landmarks for taking angles and bearings—structures and natural objects by day and lights by night.

At *F*, he has depth contours for use with an echo sounder.

At *G*, he has Loran lines of position for use with his Loran receiver by day or night.

At *H*, he has isogonic lines (lines of equal magnetic declination) to be applied to his magnetic compass.

One rightly wonders how the ancient mariner, without any of the modern navigational aids and contrivances, ever managed to reach his destination. Perhaps the answer is that very often he didn't!

THE FUTURE

The modern nautical chart is thus a synthesis of the utilitarian and the artistic, suitable for meeting present-day demands for quantity and quality reproduction. It is a scientific achievement, the evolution of which has kept pace with the territorial growth of the Nation and with the progress in science and engineering. When Thomas Jefferson set the machinery in motion a century and a half ago for surveying and charting our coastal waters, the extent of the coastline was confined to the Atlantic seaboard and to a small stretch along the Gulf of Mexico—comprising in all about 25,000 statute miles. Through the years, this program has been patterned to a developing and expanding America, and today the charting responsibility of the Coast Survey embraces nearly 100,000 miles of coastline and some 2,500,000 square miles of adjoining water area.

The Survey views with gratifying pride the contributions it has made to the development of the nautical chart. But its mission is not yet ended, nor will it ever be as long as changes wrought by man and nature leave their impress on our shores. Change and not stability is the order of nature. This finds significant expression along the seacoast and the littoral.

Offshore, there are large areas, sparsely or inadequately surveyed, that require resurveys to insure the safety of nuclear-powered submarines and to meet the ever-chang-

FIGURE 14.—Coast and Geodetic Survey ship *Pioneer* under the Golden Gate Bridge. One of the modern vessels used in offshore hydrographic surveying.

ing and more exacting requirements of modern surface craft. As a byproduct, these surveys of the continental shelves will increase in importance as technology advances and makes practicable the recovery of resources the shelves are known to contain.

In Alaska, much surveying and charting remain to be done in support of the strategic defense of the Territory and in anticipation of increased commercial activity there.

As for the chart proper, it is fair to assume that its design has been stabilized, although not necessarily permanently fixed. Changes that will be made in the foreseeable future will result primarily from developments in navigation techniques and standards. The advent of echo sounders resulted in the development of a "depth-contour chart" and the Loran system of navigation necessitated changes in the conventional type of chart. New systems of navigation and new standards may require further modifications in the character of the chart. "Navigation with safety and assurance" has been the guiding principle of the Coast Survey in its program of nautical charting. This will continue to be its motto in the days ahead, and it will fashion its charts to the needs of maritime interests. (Fig. 14.)

Belgian Surveyors Elect a New President

Professional surveyors of Belgium—l'Ordre des Geometres (French) or de Orde der Landmeters (Flemish)—in their two-language journal have announced the election of Monsieur Achille Lekeux, Chevalier de l'Ordre de la Couronne, a professional land surveyor and burgomaster of Grand-Halleux (Province of Luxemburg), to be their new President.

Past President, Dr. h.c. Paul Terlinck, becomes Honorary President in charge of exterior relations, with address at Rue Sanderus 12, Antwerp, Belgium.

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Twin Photography for Mapping Alaska's Brooks Range

By HUGH B. LOVING

U. S. GEOLOGICAL SURVEY

THIS PAPER DEALS with the planning and execution of precision aerial photography for mapping one of the most rugged and remote areas on the North American Continent—the Brooks Range, Alaska. This photography is part of a pioneer mapping venture employing a whole series of relatively new techniques. In the aerial photography phase of the project, the system chosen was twin low-oblique photography. This represents the largest area ever photographed by such a method.

Twin low-oblique photography is taken with two cameras exposed simultaneously at each exposure station. The individual cameras are tilted so that their optical axes make an intended angle of 20 degrees with the vertical and 40 degrees with each other. As in all aerial photography, small unintentional tilt is usually present.

The Brooks Range project covers an area of more than 120,000 square miles, extending some 500 miles west from the Canadian boundary and some 250 miles north from the Yukon River. More than 90 percent of this forbidding area lies north of the Arctic Circle, with elevations rising nearly to 10,000 feet.

My role in the project was to act as the Geological Survey Staff representative in monitoring the project and coordinating its technical requirements. In this capacity, I worked directly with the contractor.

PLANNING

Planning of the project was a most important step, and this was begun in December 1954 by the Staff Photogrammetry Section of the Topographic Division and coordinated with the Rocky Mountain Region offices in Denver, Colorado. The Rocky Mountain Region offices were assigned the responsibility for mapping the entire project. Final agreement on the overall project plan—photography, field work for control, photogrammetric control extension, and compilation—was reached at a conference between Region and Staff personnel early in May 1955.

In planning the photography, there were three major factors to be considered: weather, final map specifications, and availability of control.

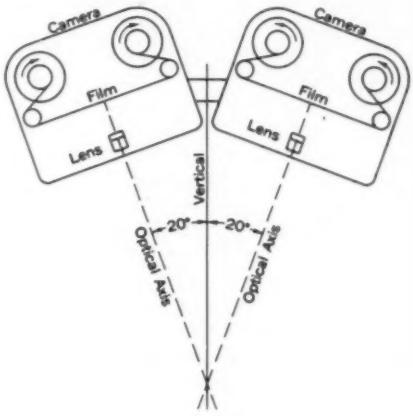

FIGURE 1.—Camera arrangement for twin low-oblique photography.

Weather

A study of Northern Alaska made it apparent, from the beginning, that the occurence of weather suitable for photography would be a major problem. Also, a study of the general pattern of the movement of air masses across the area revealed that the north and south slopes of the Brooks Range are rarely cloud free at the same time. This

Publication authorized by Director, U. S. Geological Survey.

Presented at the Seventeenth Annual Meeting of the American Congress on Surveying and Mapping, Washington, D. C., March 6–8, 1957.

FIGURE 2.—Location of Brooks Range project (shaded area) in Alaska.

circumstance, combined with the control situation, determined the east-west flight direction for the compilation photography.

Final Map Specifications

The map specifications call for a publication scale of 1:250,000 with a contour interval of 200 feet, except for some quadrangles in the southwestern portion which are to have a contour interval of 100 feet. These requirements, in combination with the need to make the most of the few occurrences of photographic weather and to keep required field control to a minimum, led us to choose transverse twin low-oblique photography for compilation.

Transverse photography is twin low-oblique photography taken with the twin cameras "aimed" at right angles to the flight line. There is a "left-looking" and a "right-looking" photograph at each exposure station. Left-looking photographs at successive stations overlap by approximately 60 percent; successive right-looking photographs overlap similarly.

Availability of Control

The available control consisted of a series

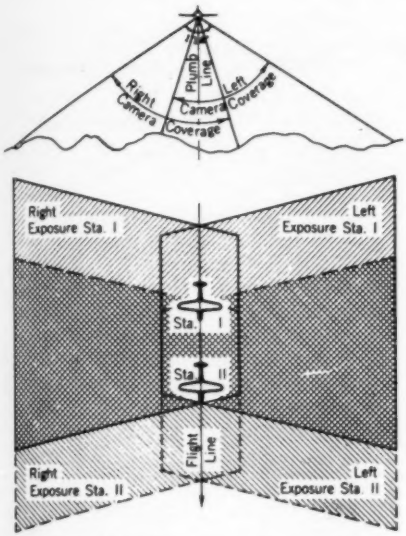

FIGURE 3.—Transverse photography.

of triangulation arcs, some completed and others definitely scheduled, which would give a continuous system of horizontal and vertical control around the perimeter of the area. In addition, the Coast and Geodetic Survey was requested to run an arc bisecting the area, from the Yukon River north through the Anaktuvuk Pass to Umiat. This arc, essential for the control of the project, was completed by the Coast and Geodetic Survey in the summer of 1955. This control plan was consistent with the plan to use east-west compilation flights. Control cross flights were also planned, consisting of convergent low-oblique photography which affords strong vertical accuracy.

Convergent photography is twin low-oblique photography taken with the twin cameras "aimed" forward and backward along the flight line, as shown. A stereoscopic overlap of 100 percent is obtained between the "forward-looking" photograph at the first exposure station and the "backward-looking" photograph at the second station. The cross flights were planned to be obtained at intervals of about 40 miles in those areas which might present unusual control difficulties.

Flight Plan

The final flight plan, developed in accordance with the foregoing considerations, called for 22 east-west transverse twin low-oblique compilation flights at 30,000 feet above mean ground, spaced 14 miles apart. The planned base-height ratio was 0.63 and the planned width-height ratio was 2.50. It should be carefully noted that vertical photography at the same altitude would require about two and one-half times as many linear miles of flight line as were required for the transverse photography.

The control flights were planned at 30,000 feet above mean ground, with a base-height ratio of 1.23. The precise location of the control flights was to be determined by the Geological Survey representative in Alaska, after he had conferred with the field control parties in the area.

BIDDING REQUIREMENTS

In the spring of 1955, invitations to bid on aerial photography covering the project were issued. Although the area to be mapped includes about 120,000 square miles, the project actually required the procurement of some 144,000 square miles of gross photographic coverage, in order to extend the flights to control. The bidding schedule called for 10,300 linear miles of transverse twin low-oblique photography and 1,300 linear miles of convergent twin low-oblique photography. The following special requirements were specified in the invitation to bid:

1. Three aircraft were required—two operational, one as a standby.

2. One pressurized operational aircraft was required for use on the flights at the higher altitudes ranging from 36,000 to 39,000 feet.

3. The crews were required to have a minimum of 10 hours of experience in commercial aerial photography at comparable altitudes.

4. The contractor was required to set up and staff a complete photographic laboratory in Alaska for the processing of film and the preparation of transformed prints for evaluation.

5. The negatives were to be exposed in a

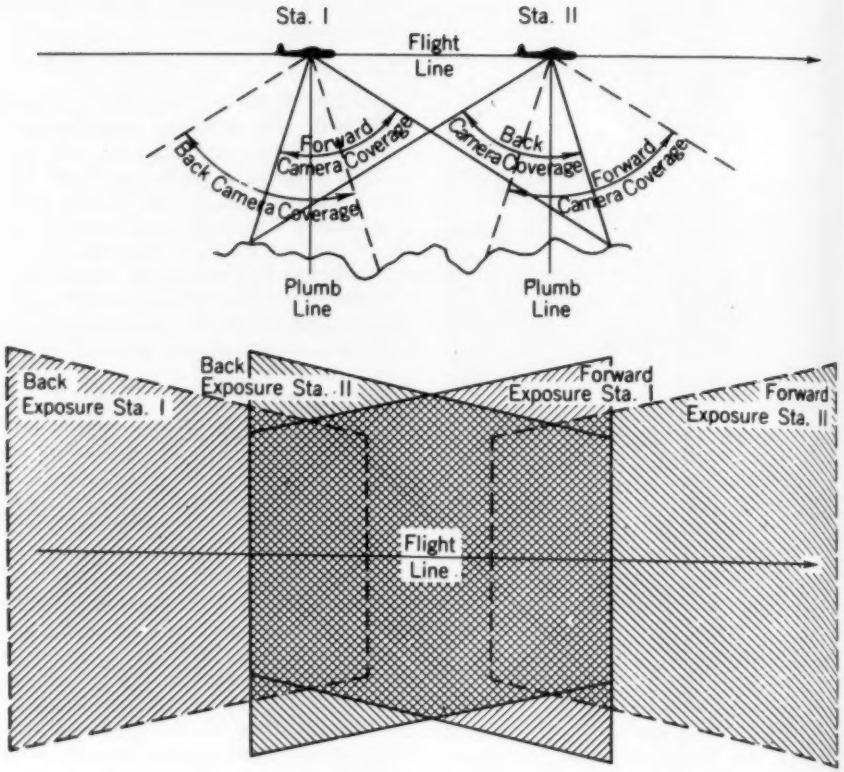

FIGURE 4.—Convergent photography.

camera couple or unit composed of two 6-inch-focal-length precision cameras. They were to be equipped with high-resolution, low-distortion lenses of the planigon type. The optical axes of the two cameras had to intersect and form an angle of 40° ± 15′; however, the angle as finally achieved was to remain constant within ± 10 seconds.

6. The optical axis and the two opposite fiducial marks of each camera were to lie in the same plane or in parallel planes as close together as possible.

7. The shutters of the two cameras had to be synchronized within 5 milliseconds.

8. The camera units had to be readily interchangeable between aircraft.

9. All equipment had to be available for inspection at the time of the opening of the bid.

Bids were received and evaluated, and the contract was awarded to Mark Hurd Aerial Surveys of Minneapolis at a price of about $20.00 per linear mile or about $1.70 per square mile.

AERIAL PHOTOGRAPHY

The contractor put forth a maximum effort on all phases of the project. All the contractor's equipment and personnel reached Alaska on schedule for both photographic seasons. In May 1955, he equipped and staffed an excellent photographic laboratory in Fairbanks. The air crews were "top-notch." This was evidenced by the small percentage of reflights required; with all the difficulties involved, the total reflights amounted to only about 8 percent.

At Bettles, the flight operational base, the contractor was supplied with gasoline, oil, and spare parts, including engines. This made for an efficient operation, but it presented some logistical problems because all the material, including gasoline, had to be shipped from Fairbanks by commercial air line.

In addition to the personnel and equipment required by the contract, two mechanics were detailed to the project for the purpose of keeping the aircraft in top-flight condition. Also, a Cessna 180 was brought to Alaska for use in reconnaissance flights and in shuttling the exposed film and reflight data between Fairbanks and Bettles.

During a 3½-month photographic season in 1955, eight favorable days occurred during which photography could be accomplished. Operations during this period yielded acceptable photography over about 85 percent of the area. Flight operations were discontinued at the end of August because of excessive snow and poor weather.

In the spring of 1956, the contract was amended to include approximately 1600 additional linear miles of photography south of latitude 66° N. on a "target-of-opportunity" basis. During the 1956 flying season the original area was completed and 77 percent of the "target-of-opportunity" area was completed.

Liaison

Liaison with other organizations was a necessary function of the assignment. Security clearances were obtained through the Alaskan Air Command, Elmendorf Air Force Base, Anchorage. Since Northern Alaska is a critical air defense area, special procedures were established concerning flight clearances with the 11th Air Division which has the air-security responsibility for the entire area covered by the contract.

As there were no public communications available, arrangements were made whereby the CAA Communications System was used to maintain contact between the flight crews and the laboratory. It was also used to transmit pertinent weather information to the operational base.

The 30th Engineers provided weather information through their field parties and used our photography for the identification of control in their area of operations. It was necessary to keep abreast of their field operations in order to take advantage of control in determining locations where flight breaks could be permitted. The 30th Engineers photo-evaluation team in Anchorage was furnished transformed prints of our photography for use in their Index of Acceptable Mapping Photography of Alaska.

The Coast and Geodetic Survey furnished the precise location of the triangulation arcs which they were executing in the area to aid us in determining advantageous flight break locations. They, in turn, were furnished transformed prints from our photography for use in planning the triangulation arc up the Chandalar River.

The 1371st Mapping and Charting Squadron provided weather data and information concerning procedures for flight clearances.

The Weather Bureau made all its data available and provided long-range forecasts for the area. The daily information provided us was instrumental in the success of the operation.

The 58th Weather Squadron furnished information from its daily weather flights in the area.

Wein Airlines also provided us with weather information. In addition they made their communications system available for our use. This airline also furnished the contractor logistical support in transporting supplies on time to the base of flight operations.

Weather Problems

Poor weather presented one of the major difficulties. In general, the air over the Brooks Range area is very unstable. Altocumulus clouds form almost daily between 8 and 9 a.m., dissipating about 6 p.m. High cirrus clouds at altitudes of 27,000 to 32,000 feet further complicate the problem. The contractor was encouraged to fly in the early morning hours which seemed to offer the best opportunity for photography.

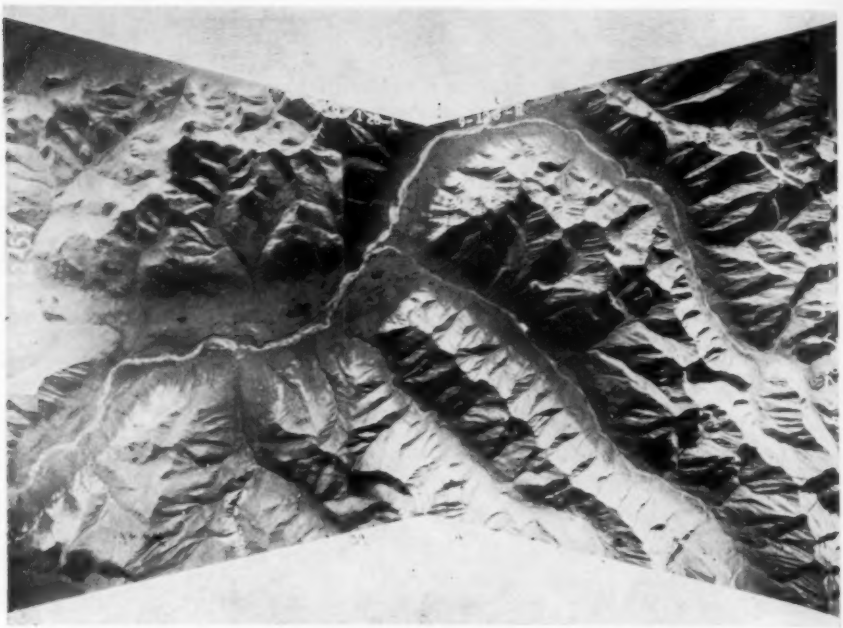

FIGURE 5.—Transverse photography obtained at a single camera station.

Many of the acceptable negatives were exposed before 8:00 a.m.

Accurate weather forecasting in Northern Alaska is very difficult. The Weather Bureau has only one station in the entire area, and the sequences obtained from Arctic coastal stations are not necessarily indicative of the weather in the interior. When this information is supplemented with the data obtained from the previously mentioned sources, it is possible to make a more accurate evaluation. This evaluation enabled the crews to change their base of operations sometimes in order to take advantage of the best weather opportunities.

Between July 1 and August 15, nearly the entire area was, at times, enveloped in smoke up to about 20,000 feet. At other times summer snows prevented operations, especially on the lower northern slopes of the Brooks Range and at the higher altitudes.

Camera Malfunctioning

Extremely low temperatures aloft, as low as −85° F., were encountered at flight altitude and were probably the cause of some of the equipment failures. The camera equipment was in direct contact with the outside air. This was in accordance with Geological Survey specifications stating that glass windows shall not be interposed between the cameras and the photographic subject.

Because of the low temperatures encountered, there was some question as to the efficiency of the camera synchronization. During the operation the cameras were returned to the Fairchild Camera and Instrument Corporation for modifications to insure synchronization. When modifications were completed, the cameras were returned to Alaska and installed in the camera couple. This entailed some changes in the wiring of the mounts and required a complete field calibration of the camera couple. Field calibration is a considerable chore when conducted without the tools available in an optical laboratory.

Condensation, on both lens and film,

presented some difficulties. On-the-job installation of camera heaters reduced the film condensation to a tolerable degree, but the problem of lens condensation was never completely overcome.

Camera failures presented a major difficulty especially when the temperatures encountered were extremely low. Operation through a temperature range of 185° F., is a large order for a piece of precision equipment such as the Fairchild T-11 mapping camera. On three consecutive days of favorable weather, camera breakdowns hampered operations. The breakdowns included lens breakage, shutter failure, failure of the main case drive, and failure of the magazine drive.

We were able to repair each of the breakdowns, thanks to replacement parts from a spare camera. After each repair job the whole camera couple had to be field calibrated for angularity and alinement. All repairs were made at night and completed in time for flights the following day. At one time, the entire inner cone and lens from one camera had to be transferred to another camera body. By the time the project was completed in September 1956 all the cameras had had some of their original parts replaced.

In addition to camera malfunctioning, there were many other operational difficulties in connection with the photographic missions. For example, on one of the missions, a photographer lost consciousness at high altitude, and a replacement had to be obtained.

CONCLUSION

The general photographic quality of the project is excellent, and well suited for the jobs of aerotriangulation and compilation. We feel very fortunate in having obtained complete photographic coverage in two short seasons, because the project presented so many unusual operational difficulties.

Certainly no job as big as this one could have been accomplished without cooperation and teamwork. All of my colleagues in the Geological Survey, both of the Washington staff and of the Rocky Mountain Region, who were concerned with the project are due credit for its successful completion. I would like also to acknowledge the excellent cooperation given by the Corp of Engineers, the Coast and Geodetic Survey, the Air Force, the CAA, the Weather Bureau, Wein Airlines, and especially the outstanding work performed under its photographic contract by Mark Hurd Aerial Surveys.

Chaos Resolved*

East is East and West is West.
It is said they never will meet:
But we multiply distance by cos and sin
And work out results in feet.

The great world spins down the grooves of change
With indeterminant steps:
But with Peters, Shortrede and Chambers'
We table the Lats. and Deps.

For there is neither East nor West,
Position, Dimension nor Shape,
Till two strong men stand face to face,
At the opposite ends of a tape.

(A.J.R.)

* Reprinted from *Empire Survey Review.*

Field Operations for Mapping Alaska's Brooks Range

By J. E. MUNDINE
U. S. GEOLOGICAL SURVEY

IN THE PRECEDING paper, Mr. Loving has described the problems of obtaining suitable mapping photography in Northern Alaska. The problems encountered in the field work for obtaining the required control for this mapping were equally challenging. In this paper, we will discuss the Geological Survey's field operations in Northern Alaska during the summer of 1956.

The Brooks Range project differed from our normal mapping projects in scale, in size and location of the project, and in its time allowance of only one summer season for completion of all field phases. It was necessary to devise new methods and procedures in order that all these requirements be fulfilled.

From past experience, we anticipated that we would have approximately 75 work days in which to complete our field operations of obtaining control for mapping, at a scale of 1:250,000 with a contour interval of 200 feet, covering a desolate Arctic area of over 120,000 square miles. A big order? Yes, we thought it a big order too. However, we were fortunate in having a group of engineers all of whom had several years of experience in Arctic mapping operations; and with mixed feelings among the men concerned, some pessimistic and some optimistic, the project was initiated.

After a thorough study of all existing data relating to the project, a decision was reached to use the stereotemplet method of extending the horizontal control, and a system which we call "photo-trig traverse" for establishing sufficient vertical control to serve as a basis for vertical stereotriangulation to develop individual model control.

Publication authorized by Director, U. S. Geological Survey.

Presented at the Seventeenth Annual Meeting of the American Congress on Surveying and Mapping, Washington, D. C., March 6–8, 1957.

As you may know, the stereotemplet method has been used for several years in establishing the horizontal control for relatively small areas and good results have been obtained. This past experience gave us assurance that the method would produce results quite adequate for larger areas.

Photo-trig traverse had not been tried heretofore on a project of this magnitude, although we have for the past ten years been utilizing the method on relatively short traverses of two or three successive stations with very excellent results. The photo-trig traverse method consists of the simultaneous observing of vertical angles between each two adjacent stations in the traverse line. These stations are selected on photo image points and the distance between the stations is obtained from the stereotemplet assembly.

In Figure 1, the area of the project is indicated by the solid black line, and the existing horizontal control arcs by the circles. Because of the exceptionally large area encompassed by the existing control in the eastern part of the project, it was decided to extend an arc of triangulation, about 140 miles long, north and south through this area, as indicated by the dashed line.

Our requirements called for vertical control in every twelfth model along each flight line, and in this case twelve models extended approximately forty miles. We therefore planned to run north-south vertical control lines at an east-west spacing of forty miles.

Figure 2 shows that there were 12 north-south lines to be run, amounting to 1700 linear miles, with an estimated 400 stations.

In order to prevent slight horizontal templet errors from producing significant vertical errors, we established specifications that no vertical angle between successive stations could be greater than 3 degrees and that the angles between successive stations were to be observed at exactly the same time.

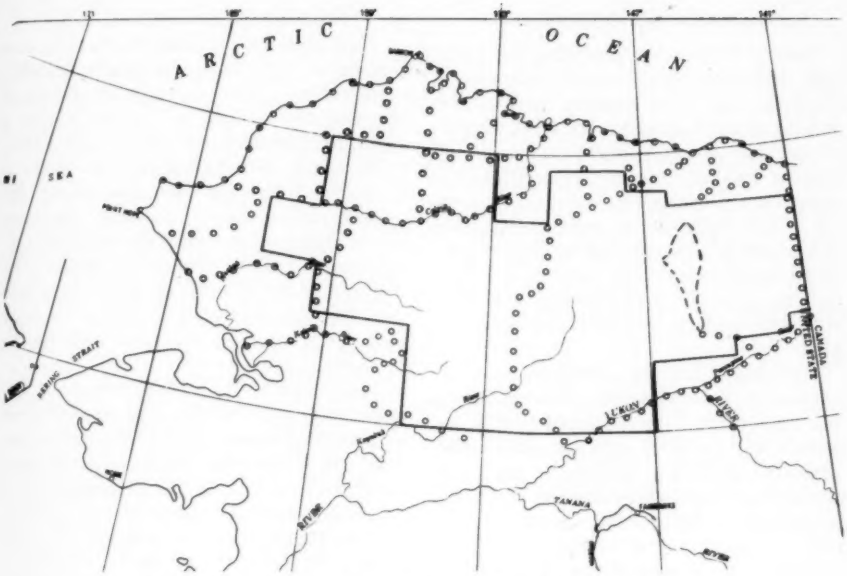

FIGURE 1.—Arcs of horizontal control, Brooks Range project.

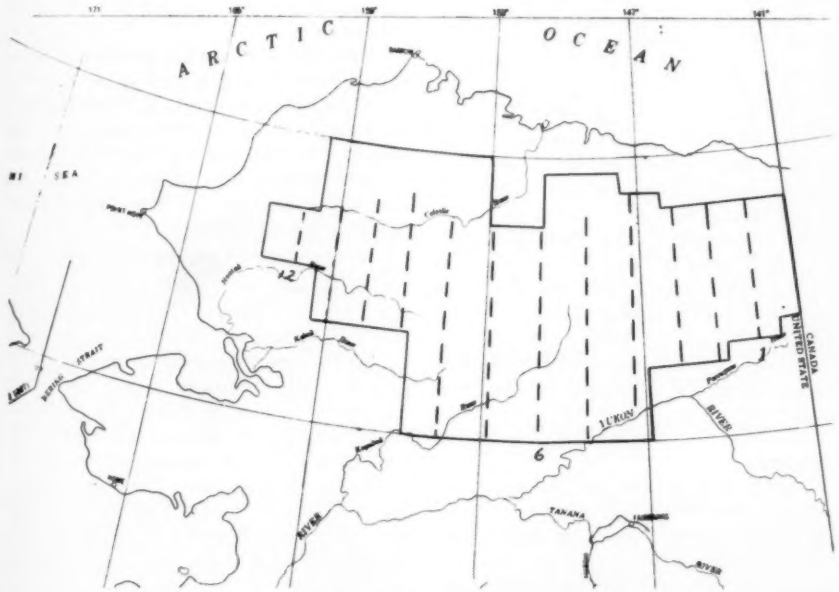

FIGURE 2.—Lines of vertical control, Brooks Range project.

PRELIMINARY OPERATIONS

During the months preceding the actual field operations, our Resident Engineer in Fairbanks was busy caching some 50,000 gallons of gasoline and other basic supplies at selected points. These caches would later be used as our source for supplying the camps as they progressed through the project. The main caches were made at the few available airstrips and on frozen lakes where large cargo ships could land. This caching job was carried out during weather which often reached 30 to 40 degrees below zero.

Meanwhile we were studying the organization of field parties. The conclusion was reached that the job could best be accomplished by three separate field units, each manned by four engineers. Each unit was assigned two helicopters and one fixed-wing aircraft. In addition, we were to have two fixed-wing aircraft which were to be utilized for supplying and moving the camps.

At the same time that the supply dumps were being established in the field, the engineer who was to be in charge of each field unit was assigned to the study and planning of each of the control lines in his area. He of course made use of all available useful data and actually made a tentative selection for each of the control points and marked them on the photographs. This planning saved many hours of work in the field and familiarized each party chief with his area of operation.

Our initial base camps were located at points A, B, and C (Figure 3) each of which had a landing strip or lake on which we could land our fixed-wing aircraft. In the case of point C, the landing strip was a frozen lake on which our supplies and gasoline were landed and unloaded. The temperature at this base on the first day of operation, May 24, dropped to 10 degrees below zero.

In order to make the most of the available good weather we began our operations at the southernmost edge of the project and worked all lines northward as the snow receded toward the crest of the Brooks Range.

PHOTO-TRIG OPERATIONS

Each photo-trig traverse line was to start and tie on a checked position and elevation.

In our procedure, an engineer at each of the first two stations in the line placed a signal light or fluorescent signal at the H. I. After communicating via two-way radio to ascertain that each was able to see the other's signal clearly, the two engineers would then simultaneously observe the vertical angles between the two stations. The engineer at the first station would then proceed to the third station where the procedure was repeated, and so on from station to station.

The engineer at station number two, while waiting for the first engineer to arrive at station three, would set the permanent mark at his station, identify, mark, and number the station on the photograph and panel the station on the ground with three 10-foot lengths of signal cloth which would radiate from the station at approximately 120-degree spacing. This paneling of the station was accomplished for the purpose of positively identifying the station on photographs which were taken of each station in the line.

As the line progressed, these identification photos for each station were taken from the fixed-wing aircraft with a K-20 aerial camera at an altitude of 5000 feet above the ground. The coverage of the K-20 camera at this altitude was adequate to tie the identification photo to the high-altitude mapping photography.

ALTIMETER OBSERVATIONS

Concurrently with each photo-trig traverse line, we executed a leapfrog altimeter line utilizing four precise altimeters, in pairs.

Our reasons for making altimeter observations along the route of the photo-trig traverse were, first, to obtain what we considered would be invaluable information regarding the use of altimeters on various types of projects; second, from past experience we felt that using the altimeters would provide a check between successive photo-trig stations so that any major error might be detected.

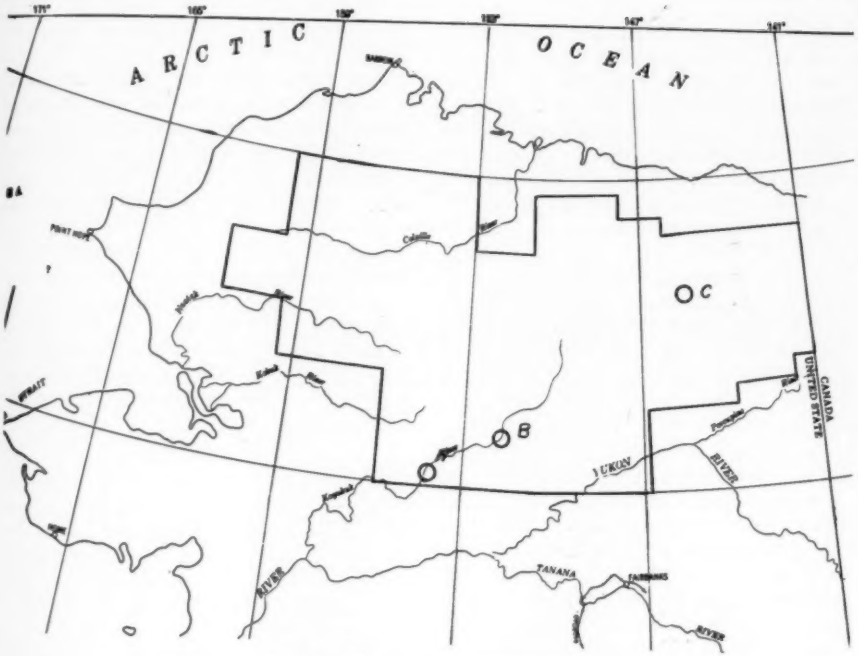

FIGURE 3.—Location of base camps, Brooks Range project.

The procedure for altimeter observation was to initiate the line coincidentally with the photo-trig traverse line, checking all four instruments at the initial point, proceed to the next station with one pair of altimeters, and make and record simultaneous observations of both pairs of instruments.

Temperature and humidity readings were taken at each station, and corrections for these readings were included in the computation of the observed data. Differential temperature readings often accounted for corrections up to 100 feet. When possible and convenient to do so, the two pairs of instruments were checked against each other throughout the day as the work progressed.

RATE OF PROGRESS

The project was initiated on May 24, which seemed like the dead of winter to the men on this assignment. Snow still covered the area, and the ice on the lakes was thick enough to support a loaded transport plane.

Fifty-seven days later, on July 20th, which was at least 30 days ahead of our most optimistic estimate, the project was completed. Of this 57-day period, the camps lost an average of 13 days each due to bad weather conditions which varied from excessively high winds to rain, fog, and snow. It is not uncommon to encounter a blizzard in this area in what we consider the middle of summer.

During the 57 days of operations, many problems arose. Fortunately, however, none seriously hampered our operations, and no time whatsoever was lost due to the need for helicopter maintenance or repair.

The field operating costs for this control project amounted to approximately $2.25 per square mile.

As of this date the stereotemplet extension of control for the eastern portion of the project has been accomplished. The adjustment of the stereotemplet assembly to all horizontal control stations was accomplished with ease. The three photo-trig traverse lines in the area have been computed and the great-

est closure on any one of these lines was 300 feet, with an average closure for the three lines of 138 feet. These closures will of course be adjusted and the resulting elevations will be well within the accuracy requirements for the project. It might be interesting to note that on our initial computation of line one, which is 140 miles in length, our traverse tied with a closure of 125 feet. After rechecking our computations and finding no error we had the control point to which we made the tie checked and discovered that an error of 120 feet had been made in the vertical-angle network which accompanied the horizontal control.

PROJECT STATISTICS

The magnitude of the project is reflected in the following interesting statistics.

We established 1654 linear miles of photo-trig traverse which contained 352 stations. The total amount of leapfrog altimetry was 2026 linear miles. This figure is higher than the length of the photo-trig traverse because we ran a number of cross-tying altimeter lines which amounted to 372 miles of line and 81 additional stations.

Seventeen international boundary markers along a 100-mile section of the Alaska-Canada boundary were recovered, photo-identified, paneled and photographed.

On our Alaskan projects, the advance field completion phase is always executed concurrently with our control operations and the total number of K-20 aerial photos taken for purposes of control identification and field completion amounted to over 3000 exposures. This photography was flown to Fairbanks and processed almost on a daily basis in order to be assured that good quality prints had been obtained before the crews moved out of the area.

Although the area of the project is very sparsely inhabited, with many portions almost totally inaccessible, our field-completion investigations produced over 3000 new place names which have been heretofore unpublished. Our only source of supplies, of any type, was Fairbanks, which is over 100 airline miles south of the southern boundary of the project.

One factor which contributed greatly to the success of the operation was the use of two-way radio communications between every camp and field unit, and with our headquarters in Fairbanks. This project would have been prolonged over several summer seasons had we not had this very dependable communication system consisting of 25-watt transceivers in Fairbanks and at each base camp, and a 3-watt transceiver with each field engineer. No observation of either the vertical angles or the altimeters was ever made without the engineers on the two successive stations being in communication with each other.

CONCLUSION

The Brooks Range project represents a bold solution for a difficult problem. New techniques, hitherto untried in a job of this magnitude, were involved in virtually every step of the procedure. It is true that there were risks of failure all along the line; but they were calculated risks that had to be taken, for the job could not be done, in the time allotted and at a reasonable cost, by conventional methods.

There are many factors that have contributed to the success of this project. These include, of course, new and improved methods and equipment, logistical support by helicopters and planes, and experienced personnel. However, by far, the most important in my opinion was well coordinated planning, involving the technical staff in Washington, regional headquarters in Denver, our project engineer stationed in Alaska, and every fieldman assigned to the project. In addition, we received, at all levels, the fullest cooperation from the Office of the Chief of Engineers, the United States Air Force, the Coast and Geodetic Survey, the Weather Bureau, the Alaska Command, the contractors who accomplished the aerial photography and those who furnished helicopters and planes. In other words, the project from start to finish was one of CO-ORDINATION and COOPERATION.

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The Tellurometer
Some Uses and Advantages

By FLOYD W. HOUGH

CONSULTING GEODETIC ENGINEER[1]

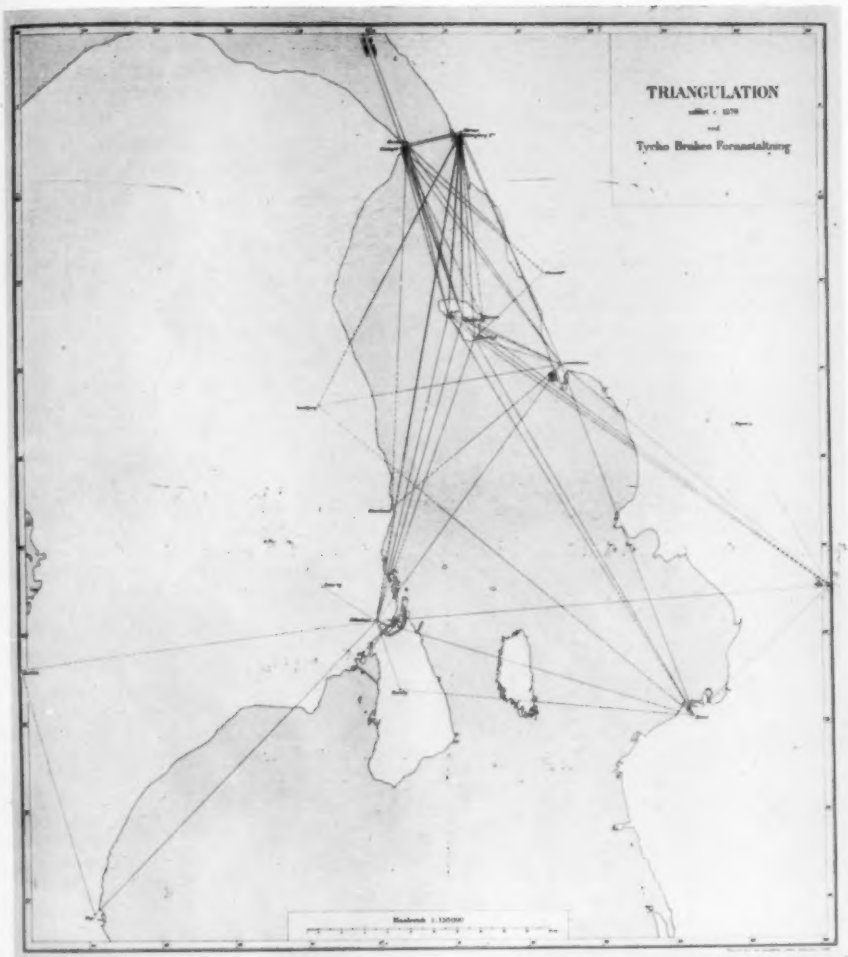
SURVEYORS for the past four centuries have generally determined accurate distances over the ground by either of two classical methods: one known as *traverse*, direct measurement by chain or tape, and the observation of deflection angles; the other known as *triangulation*, the trigonometric solution of triangle sides from the measured angles and base lines in arc or area systems. Tycho Brahe, the Danish astronomer and geodesist, in 1573, established in Denmark what is generally recognized to have been the first arc of triangulation. (Fig. 1.) While rather weak in "strength of figure," this arc is not dissimilar to triangulation of the present day. It should be remembered, too, that Tycho Brahe's arc was measured 30 years before the telescope was invented. He obtained his angles by lining in his "rifle" sights on distant objects which he could see with the unaided eye. He measured two bases, one near Copenhagen and a second on the ice of the Skagerrak. He obtained his astronomic position from a Danish station the remains of which, according to a statement to the author by Professor Nørlund of Denmark, are still visible on an island near Copenhagen.

This age of electronics has recently produced a new and practical facility for the surveyor, christened the TELLUROMETER. The device employs radio waves in the measurement of distance.

In 1954, Colonel Harry A. Baumann, then Director of the South African Trigonometrical Survey, advanced this idea of using radio waves to determine ground distances with geodetic accuracy. He arranged for a study and development of this idea. Prior to the TELLUROMETER, the only successful electronic developments for direct ground measurement of distance employed light waves as the carrier. It had been thought that the propagation of radio waves would be too susceptible to error due to ground reflection and diffraction and hence that distance determination based on the velocity of these radio waves would be affected too adversely for geodetic accuracy. Repeated demonstrations of the TELLUROMETER have proved conclusively that any cumulative interference with a consistent velocity of propagation is not sufficient to prevent the attainment of accuracy suitable for geodetic measurements of lines up to at least 35 miles in length.

Extensive field tests of the TELLUROMETER in South Africa and in England, over lines of known geodetic length, show that the system will measure distances of from 10 to 35 miles with an accuracy of about 1 part in 200,000. To attain this accuracy, corrections are applied. These result from simple meteorological readings made at each end of the line at the time of measurement. Distances between 300 feet and 10 miles may be measured satisfactorily with lesser accuracy. The upper range of the present development may be close to 100 miles although the ground reflection and diffraction effects will reduce appreciably the anticipated accuracy above mentioned. While unobstructed lines of sight are a generally required condition, distances between 300 feet and 20 miles may be measured when this condition is not entirely present. Although a predetermined length of line to be measured must be known within 10 miles, it is obvious that an ambiguity of this size is seldom detrimental to a proposed measurement. The design of the TELLUROMETER system is such as to make the delay error at the remote station negligible in practice.

[1] Formerly Chief, Geodetic Division, United States Army Map Service.



Included thru the courtesy of Prof. N. E. Nörlund, Director of the Geodetic Institute of Denmark

FIGURE 1.

The manufacturer in Cape Town gives the following description of the TELLUROMETER (Fig. 2.) which is quoted verbatim:

Description—The TELLUROMETER operates in the 10 cm. wave-length region and measures the travel time of radio waves over the length to be determined with an accuracy of a fraction of a millimicro-second. Measurements can be made by day or by night and visibility is immaterial. In general, optical line of sight is required over the length to be measured, but this point is dealt with more fully under "Range."

To measure a single line, one master station and one remote station are necessary. Measurements are made at the master station and an operator is required at the remote station. A built-in duplex radio telephone circuit is included in the system and is used in the measurement procedure. · If a number of remote stations are employed, a number of lines may be measured from the station in the course of one

operation, with possible economies in transport and time.

The instruments at master and remote stations are physically very similar but at the present stage of development they are not interchangeable.

The instrument (master or remote) is a self-contained unit with built-in aerial system. Models now being developed will weigh approximately 16 lbs. When packed, the over-all dimensions will be approximately 20 in. × 19 in. × 9 in. The power consumption of each unit is 6 volts-8 amps. D.C.

Accessories for use with each instrument are as follows:

FIGURE 2.—The TELLUROMETER instrument in operation. Carrying case, power pack, and battery are also shown.

Power supply unit: approximately 10 lbs.
Tripod: approximately 6 lbs.
6 volt 40 amp-hour accumulator—
standard type or special lightweight type as required.
Whirling hygrometer and aneroid barometer.

The instruments are robust and operation is simple and straightforward. Measurements are quickly made, half an hour being more than adequate, including unpacking and packing of the equipment. It is suitable for operation on a simple scaffolding or tower, in which the stability required for theodolite is not necessary.

In April of this year, the Ordnance Survey of Great Britain, conducted public field tests of the TELLUROMETER at the Ridge Way Base and its adjacent primary stations. (Fig. 3.) The notes on these tests and the tabulated results as published by the Ordnance Survey are reproduced verbatim below:

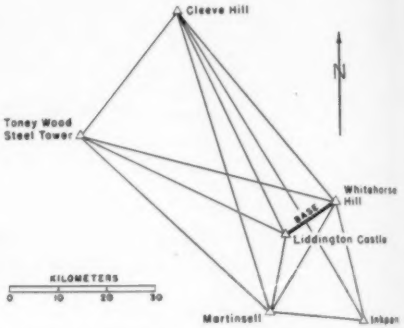


FIGURE 3.—Ridgeway Base Net of the Ordnance Survey of Great Britain.

NOTES

1. The lengths of the primary sides of the Retriangulation of Great Britain accepted for the National Grid were not derived from the modern measured bases. For this trial, however, a readjustment of the base figure was done using the observed primary angles and the measured length of the Ridge Way Base. This was done in order to obtain the most accurate triangulation lengths for comparison with the TELLUROMETER lengths (Tables 1 and 2).

2. The ray Peglers Tump—Martinsell, which was observed in 1936, is now heavily obstructed by trees near Peglers Tump. In order to observe the complete figure with the TELLUROMETER, a steel tower had to be erected at an auxiliary position (Toney Wood) about 300 meters from the primary station at Peglers Tump. The triangulation lengths derived from this auxiliary position are considered to be slightly less accurate than those of the actual primary trigonometric sides. Separate tables of comparisons are therefore given for the 4 rays measured from Toney Wood steel tower. (Tables 3 and 4.)

3. Two values for the velocity of light in vacuo have been used in this comparison:

299,792.0 kms/sec. (The value accepted by the International Scientific Radio Union in 1954).

FIGURE 4.—TELLUROMETER demonstration near Rockville, Md.

299,792.8 kms/sec. (The value derived from TELLUROMETER measurements on the Ridge Way Base).

The value derived by the Ordnance Survey from the GEODIMETER measurement of the Ridge Way Base in 1953 (299,792.4 kms/sec) has not been used.

Subsequent to the British Ordnance Survey tests, visiting TELLUROMETER officials from South Africa, on May 3, 1957, sponsored a technical discussion of their product before an audience in Washington, D. C., composed of about 100 engineers and scientists from the military services, Federal civil agencies, and private life. On the following day, most of this same group witnessed a field demonstration of the TELLUROMETER system by the South African visitors, assisted by personnel of the Coast and Geodetic Survey and the Engineer Research and Development Laboratories of Fort Belvoir, Virginia. The demonstration (Fig. 4 and Fig. 5) comprised the measurement of an eight-mile line near Rockville, Md., whose length had been accurately determined previously by the Coast and Geodetic Survey, both from triangulation and by the GEODIMETER. The remote station was operated by a member of the Coast and Geodetic Survey, who was unfamiliar with the TELLUROMETER except for operational training during a two-hour period of the previous afternoon. No rehearsal was held prior to the public demonstration.

FIGURE 5.—TELLUROMETER in operation near Rockville, Md.

With the master and remote instruments in place on the two ends of the Rockville line, the South African scientist asked that the watch time be recorded when he would give the signal that the "rough" reading was to be started. In something less than 90 seconds, he had read and announced the "rough" distance as 12,810.9 meters; this proved to be 2.5 feet less than the C&GS length. The 2.5 foot discrepancy in the rough reading, obtained in less than 1½ minutes after set up, represents a proportional error of 1 part in 16,000 on the eight-

TABLE 1.

Velocity of light in vacuo: 299,792.0 km/sec.

Line		Spheroidal Length (Meters)			
From	To	Triangulation (1)	Tellurometer (2)	Diff. (2–1)	Proportional Error
White Horse Hill	Liddington Castle	11,260.189	11,260.159	−0.030	375,000
	Inkpen	25,803.588	25,803.453	−0.135	191,000
	Martinsell	25,633.740	25,633.696	−0.044	583,000
	Cleve Hill	48,846.390	48,846.230	−0.160	305,000
Liddington Castle	Inkpen	24,430.861	24,430.772	−0.089	275,000
	Martinsell	16,200.132	16,200.124	−0.008	2,025,000
	Cleeve Hill	49,655.951	49,655.759	−0.192	259,000
Inkpen	Martinsell	19,645.250	19,645.235	−0.015	1,310,000
	Cleeve Hill	73,394.841	73,394.964	+0.123	597,000
Martinsell	Cleeve Hill	63,402.434	63,402.368	−0.066	961,000

TABLE 2.

Velocity of light in vacuo: 299,792.8 km/sec.

Line		Spheroidal Length (Meters)			
From	To	Triangulation (1)	Tellurometer (2)	Diff. (2–1)	Proportional Error
White Horse Hill	Liddington Castle	11,260.189	11,260.189	0.000	—
	Inkpen	25,803.588	25,803.522	−0.066	391,000
	Martinsell	25,633.740	25,633.764	+0.024	1,068,000
	Cleeve Hill	48,846.390	48,846.360	−0.030	1,628,000
Liddington Castle	Inkpen	24,430.861	24,430.837	−0.024	1,018,000
	Martinsell	16,200.132	16,200.168	+0.036	450,000
	Cleeve Hill	49,655.951	49,655.892	−0.059	842,000
Inkpen	Martinsell	19,645.250	19,645.287	+0.037	531,000
	Cleeve Hill	73,394.841	73,395.160	+0.319	230,000
Martinsell	Cleeve Hill	63,402.434	63,402.537	+0.103	616,000

TABLE 3.

Velocity of light in vacuo: 299,792.0 km/sec.

Line		Spheroidal Length (Meters)			
From	To	Triangulation (1)	Tellurometer (2)	Diff. (2–1)	Proportional Error
Toney Wood S.T.	White Horse Hill	52,644.263	52,644.087	−0.176	299,000
	Liddington Castle	46,381.522	46,381.539	+0.017	2,728,000
	Martinsell	52,838.062	52,837.882	−0.180	294,000
	Cleeve Hill	32,072.344	32,072.318	−0.026	1,234,000

TABLE 4.

Velocity of light in vacuo: 299,792.8 km/sec.

Line		Spheroidal Length (Meters)			
From	To	Triangulation (1)	Tellurometer (2)	Diff. (2–1)	Proportional Error
Toney Wood S.T.	White Horse Hill	52,644.263	52,644.228	−0.035	1,504,000
	Liddington Castle	46,381.522	46,381.663	+0.141	329,000
	Martinsell	52,838.062	52,838.023	−0.039	1,355,000
	Cleeve Hill	32,072.344	32,072.404	+0.060	535,000

mile line. The significance of this rapidly obtained "rough" measurement, amounting to second-order acuracy, is immediately apparent to the many surveyors for whom an accuracy of 1 part in 10,000 is generally adequate. Following the announcement of the rough reading, the fine readings and meteorological notes were taken at both the master and remote stations, those from the remote station being passed to the master by radio telephone over the TELLUROMETER circuit. Final computations were then made in 30 minutes at the master station and the TELLUROMETER distance was announced as 12,811.60 meters. This compared with the C&GS GEODIMETER distance of 12,811.66 meters, or 1 part in 213,000. The C&GS triangulation distance on the same slope line was 12,811.79 meters. The latter computed length was derived from computation through about 12 triangles whose accumulation of R 1 in the strength of figure amounted to approximately 35. Hence, the direct GEODIMETER length is considered superior to the first-order triangulation distance. The velocity of propagation of 299,793.1 km/sec. was used in both the GEODIMETER and TELLUROMETER computations.

Let us now consider some of the apparent advantages of the TELLUROMETER as they concern the geodesist and surveyor:

(a) *Daytime work*—Probably its most important advantage is its capability of daytime use due to its employment of radio waves as carrier rather than light waves; in this, it is unique in its field. No longer do we need to operate at night in electronic ground measurements, nor do we have to wait for the winter season in high latitudes.

(b) *Light weight*—The equipment, totaling about 85 pounds, is suitable for backpacking to mountain stations, since the heaviest single unit is 28 pounds.

(c) *Optical visibility not required*—While "line-of-sight" is the normal condition to be met, seeing over the line is not a factor. Work can proceed in foggy or even rainy weather. It is obvious that this insurance against weather delays should be of much interest to the contractor who has a time schedule to meet.

(d) *Rugged construction*—No special handling beyond that normally accorded a transit is required. The TELLUROMETER has been transported in the field by truck over rough roads with no subsequent adjustments necessary. An inspection of the component parts of the set confirms this claim to rigidity.

(e) *Simplicity of operation*—An expert in electronics is not required. The operator of the master unit can be adequately trained in a few days and that of the remote unit in a matter of hours.

(f) *Quick setup*—it is apparent that experienced observers on tranverse work will require about 30 minutes at the station to set up, observe, and dismantle the equipment; less time will be needed if an accuracy of 1 part in 10,000 or less is adequate.

(g) *Tower support*—Where necessary to overcome curvature or other obstruction, both master and remote units are capable of functioning on high towers or buildings without separate observer support.

(h) *Low relative cost*—The TELLUROMETER system is priced to bring it within reach of small survey organizations.

Some obvious practical uses of this new aid to the geodesist and surveyor will include the following:

(a) *Traverse*—Particularly in rough or brush country where the terrain is unsuitable for rapid chaining; a small transit or theodolite will be required to measure the horizontal and vertical angles in any traverse operations.

(b) *Picture points*—Here the TELLUROMETER will be used to much advantage under nonvisibility weather conditions in the rapid location of numerous photogrammetric control points. In open country, particularly in much of the West, master units on two relatively high triangulation stations or on steel towers, together with roving remote units, can quickly, accurately, and cheaply furnish the positions of a considerable number of picture points from the same two master unit stations. This work can proceed not only in the daytime or nighttime, but also in foggy or even rainy weather. It appears likely that the "rough" readings of the TELLUROMETER, mentioned previously in

this paper, would be adequate, in most instances, to furnish the required accuracy for horizontal picture-point location without the necessity for "fine" readings or for meteorological corrections. Altimeters will furnish elevations adequate for reduction to horizontal of the TELLUROMETER slope distances. In medium and small scale mapping, altimeter elevations should generally suffice as vertical control.

(c) *Base lines*—The lengths of sides in geodetic area or arc triangulation can be measured frequently at high or low stations, thus obviating "base nets" or paucity in measured lines. The ease and economy with which the TELLUROMETER can be used for this purpose mean a higher geodetic accuracy can be maintained throughout the triangulation, since economy will no longer dictate the heretofore necessary loss in strength of figure before a new base is justified.

(d) *Strengthening of existing triangulation*—The same ease and economy will enable the TELLUROMETER to insert measured bases into existing arcs or areas of what is now designated third- or second-order triangulation and thus make it possible, along with additional astronomic azimuths, to raise the accuracy classification of these surveys without remeasurement of the angles. This will be true also of much of the triangulation falling under Classes 2 and 3 of the first-order, those categories established under the new accuracy classification standards of the Federal Government to replace the standards of the old Board of Surveys and Maps.[2]

(e) *Occasional trilateration*—The measurement by TELLUROMETER of all lines (trilateration) in arcs or in area control where the weather is such as to delay seriously or to prevent the visual measurement of angles by theodolite. (The author has in mind an occasion, in August 1923, when his first-order triangulation party of the Coast and Geodetic Survey was delayed three full weeks because of fog conditions in the Santa Barbara Channel area. It then became imperative for him to suspend all operations and move the party to the Imperial Valley. This intense fog condition continued for some further period during which seven destroyers of the U. S. Navy went aground and were lost off Point Arguello.) In such a situation as that described, or even one much less aggravated, the observations could continue without interruption by the simple process of substituting TELLUROMETER trilateration for triangulation.

(f) *Military applications*—The above suggested uses will find application in the various military services. In addition, the TELLUROMETER should be of real significance in the extension of horizontal control for the location of artillery and guided missile installations, particularly because of its daytime as well as nighttime capability under adverse weather conditions of nonvisibility.

During a visit to Cape Town in 1952, the author was most favorably impressed by the faculty, students, campus, and equipment of the University, and by the operations of the Trigonometrical Survey. This Survey, closely allied to the University, was headed by Colonel Baumann who, the following year, was to conceive the idea of the TELLUROMETER and the general principles on which it should be designed. Mr. T. L. Wadley and his staff, of the Telecommunications Research Laboratory of the South African Council for Scientific Research, conducted the investigation and the detailed design of the new equipment to its successful conclusion. It appears that this sound background of scientific personnel and laboratory facilities in the Union of South Africa is responsible for a product of outstanding value to the geodetic engineer and surveyor. It is practical and within reach of educational institutions and many private surveying organizations, as well as those of the Federal Government, States, and municipalities. Its use should accelerate the already current tendency toward higher standards of surveying.

[2] These new classifications had not been finally approved at the time this manuscript was prepared for publication.

The Use of Electronic Computers in Teaching Surveying

By PROFESSOR A. J. McNAIR

HEAD, SURVEYING DEPARTMENT, CORNELL UNIVERSITY

NO ONE can doubt that electronic computers are here to stay. Their presence is one more step in the trend to mechanization of human effort and relieving man of laborious operations. Over the past two or three generations, mathematical computations have climbed the steps from longhand, using pencil and paper and the procedure of casting out nines for check purposes, through the use of logarithms, slide rule, and desk calculator, to the electronic computers. Probably the greatest step taken between any two of these methods, as far as reduction in time of computation is concerned, is the last step between the desk calculator and the electronic computer.

It should be noted here immediately that there are two types of computers. This is as true of the electronic computers as of other more conventional types. These two types are the digital and the analogue. Digital computers are the pencil and paper of longhand arithmetic or the desk calculators, whereas analogue calculators set up a device which by analogy represents the quantities to be computed in a given problem. Thus, a slide rule is an analogue computer, and, without too much stretch of the imagination, the stereoplotter in photogrammetry is an analogue of the problems set up in aerial photogrammetry. There are also both electrical and electronic analogue computers devised for special purposes. An excellent example of one of these is the ESNA or Electrical Survey Net Adjuster developed by the U. S. Geological Survey to represent the quantities which are to be adjusted in a level net. With one or two notable exceptions, such as the one just mentioned, analogue computers usually are not sufficient for the problems encountered in surveying. The precisions employed in surveying are usually at least 1:5,000, while precisions of 1:1,000,000, especially in the geodetic work, are not uncommon. Analogue computers, which usually provide only the first two or three significant figures in a result, are almost totally inadequate for the problems in surveying.

ELECTRONIC DIGITAL COMPUTERS

Hereafter reference to electronic computers should be understood to mean exclusively digital computers. I am not recommending any particular type of computer. My personal experience is extremely limited, being restricted to three types of machines and two makes—the IBM electronic card program calculator, or so-called CPC; the IBM 650 magnetic drum calculator; and the Remington Rand UNIVAC. The manufacturers of electronic calculators are going through a period somewhat akin to that experienced by the automobile makers. Quite a number of special-purpose computers have been designed and built. Some of these computers are now "orphans." Patent rights to others have been bought up by major companies. Several of the computer manufacturers are better known for their manufacture of aircraft and aviation instruments. These machines are not particularly adapted to the problems encountered in surveying and, more particularly, are not well adapted to teaching surveying in a general-purpose course.

The language in which a general-purpose computer is designed to accept its instructions is naturally designed for maximum efficiency and generality consistent with keeping the machine itself as simple as possible. This results in a language which is rather difficult for the uninitiated to use. This has been a deterrent to use of the

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machine for relatively short-run problems. However, most of the available computers have been programmed to simulate more specialized machines having instruction language in which it is far easier to set up a restricted range of problems such as engineering computations. This makes it possible for an inexperienced person, such as the originator of a problem, to put his own problem on a machine and solve it with a minimum of assistance from machine specialists. This may be expensive in terms of actual machine efficiency. This may result in a decrease of machine running speed by factors up to 20, but, for a relatively short problem representing less than a man-week of computation, the net effect is usually a more efficient operation. Most machines operate in what is known as fixed decimal form, but in engineering it is usually necessary to operate with a specified number of significant figures. Consequently, the machine is programmed to carry a specified number of significant digits together with a ten's exponent to indicate the order of magnitude of the quantity. In a typical system, approximately 50 such codes take care of most of the ordinary mathematical operations and elementary functions. Of course others can be added to the repertoire in the memory as desired.

TEACHING SURVEYING

I should now like to return to the subject of this paper, the use of electronic computers in teaching surveying. At the present moment this is a very exciting subject, with new developments and uses appearing continually. However, I wonder if there would have been a single individual at this meeting if the announced subject had been the use of the slide rule in teaching surveying, or the use of logarithms in teaching surveying. I cannot help but feel that perhaps 20 or 30 years from now the subject of this paper will seem as dull as either of the other two I have suggested. This is not to say that I feel the subject of teaching surveying will be dull at that time. On the contrary, I feel that surveying, which, basically, is the process of making measurements on or near the earth's surface, will be at least as interesting 30 years from now as it is at the present moment. It may be that we will be surveying at the bottom of the ocean or miles under the surface of the earth. It may be we will be measuring the moon or some planet—or we may still be trying to get our first complete topographic map of the United States. We may be settling a dispute between two neighbors over a property boundary, but the fundamentals of surveying will be unchanged even though the techniques and instruments may be so different as to be unrecognizable to us at present.

The question then arises as to how we may make the best use of electronic computers in teaching surveying. One of the very important values is the requirement that computations be thoroughly organized. Programming concepts are fundamental to all types of computers. With pencil and paper a student frequently gets careless habits of picking out numbers somewhat at random and operating on them. He neglects to analyze his problem completely and to organize his computations in an orderly manner. More especially he usually thinks only in terms of the one particular problem at hand without considering the limiting values of his parameters. Programming for an electronic computer requires complete planning of the quantities and operations in the entire problem so as to take maximum advantage of repetitious occurrence of these operations. The programmer must also consider such things as the size of the quantities, number of significant figures required, and positive and negative limits. This is excellent discipline for engineering students. It is also good for the instructors and for practicing engineers.

CORNELL COMPUTING CENTER

It is agreed that in engineering our goal should not be the training of technicians. Thus, we are not trying to train slide rule operators, handbook engineers, multiplex operators, or programmers for electronic computers. At Cornell we do not have a course in the Engineering College on slide rule. However, the upper classmen in the engineering honorary, Tau Beta Pi, once

or twice a year operate a short course type of program teaching the use of the slide rule. Similarly, at Cornell we do not have a course in the Enginering College on either desk calculators or electronic computers. The students learn the use of desk calculators in their various courses, particularly in the surveying and statistics courses.

The Cornell Computing Center, a separate department in the university, which has operated for several years, offers a series of lectures on programming for the IBM 650 drum calculator which they have. A great number of graduate students and quite a few undergraduate students attend these instructional periods which give sufficient information that a beginner using the interpretative routine can program any of the simpler problems. Staff members of the Computing Center are always available to check over the programming and to assist with any more complicated programming. Of course there are expert programmers available to program for or to assist with programming any complicated problems, particularly those where it is more desirable to carry out the computations in machine language.

DETAILED PROBLEMS

Let us consider now some problems where electronic computers can be of the most value in teaching surveying. In surveying, as in most other fields of study in engineering, there is not time for detailed, elaborate, and repetitious computations. The principles and learning to think are the important items. However, there are several important places where the extreme speed and facility of electronic computers are valuable. Some of these repetitious operations are the computation of latitudes and departures of traverse lines and the computation of coordinates of traverse points. At our Summer Survey Camp our field parties, for their secondary control traverses, obtain tape traverses consisting of 25 to 50 sides. After our students have done a sufficient amount of manual computing, we take the observed data—and the students—to the Computing Center where they have an opportunity to see the data processed and learn how the machines operate. There they punch the few necessary cards for the input data and follow the computations through the machine. The computation consists of converting the azimuths and lengths of the traverse to latitudes and departures which are added consecutively to the coordinates of an initial point. If the traverse closes within the required limit of 1:5000, the machine will then continue the computations. If not, the students look for their mistakes. If the test is passed, the machine then proceeds to make an adjustment according to any prescribed rule—the one we are using now is the transit rule. New coordinates are computed. The machine then computes the revised azimuths and lengths for each line in the traverse. The computer requires a total of approximately 3 seconds to compute and adjust each traverse course. If all ten parties, each with a 50-course traverse, were to arrive at the Computing Center at once, all the traverses would be computed and adjusted and the revised coordinates, azimuths, and lengths would be tabulated in approximately a half hour.

As another example, our students in photogrammetry may spend ten hours on the desk calculator, working out the space resection and orientation of an aerial photograph. We then spend one or two hours discussing machine programming for this problem. This may be the student's first introduction to electronic computing. They do very little actual programming. To completely program this problem would require perhaps five hours with some guidance. They then punch the four input cards which are required and have the pleasure of seeing the same problem computed in somewhat less than three minutes.

Similarly, a student, in writing a term paper or in developing a senior project, may conduct a study involving what would otherwise be a prohibitive volume of computations to arrive at given results. This may be something in the nature of a statistical study. One student studied the effect of errors in film shrinkage on the space resection of an aerial photograph. The study

would have taken a prohibitive 400 hours on a desk calculator. Another student studied the effect of errors in focal length on extension of a strip of aerial photographs.

Another interesting use of the computer is the flexibility which it gives the professor in assigning problems to his classes. For instance, with no malice aforethought, he can assign different values for a problem to each student in the class, program the problem once, and compute the 20 or more individual solutions in five minutes. When the student's results are submitted, a large number of very interesting correlations can be made. Not the least of these is the opportunity to observe how the results change, for instance, with the introduction of increment values to the original input data.

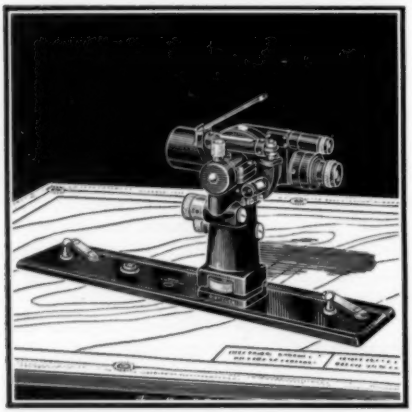
New Process for Printing Military Maps

Development of a process for printing military maps from lithographic plates prepared by the xerographic technique has been announced by the U. S. Army Engineer Research and Development Laboratories, Fort Belvoir, Va.

In this new process, xerographic images are prepared and fixed directly on the xerographic plate, and the nonimage area of the plate is converted chemically to a water-receptive surface. The resulting plate is then placed in an offset press and lithographic prints are obtained using conventional lithographic procedures. Press runs up to 25,000 impressions have been obtained with a printing quality comparable to that obtained in good quality lithographic printing.

Developed by the Map Reproduction Branch of the Laboratories in conjunction with the Haloid Company and the Battelle Memorial Institute, the process offers a number of advantages over present lithographic platemaking techniques for printing military maps. One of the most important is that the level of illumination required for exposure is much less so that plates may be exposed directly in a camera and, thereby, eliminate intermediate photographic steps.

The plates are not damaged permanently either by accidental exposure to light or other radiations, or by errors made during the exposure or development steps. The plates are both positive and negative working, and the shelf life of the plate is excellent.



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Standardized Computations for Subdivisions

By HAROLD J. WELCH, P.E., R.L.S.

REYNOLDS, SMITH & HILLS, ARCHITECTS & ENGINEERS

The title of this paper, as it appears above, has been retained because it is in agreement with that under which the paper was presented at the Seventeenth Annual Meeting of ACSM, March 7, 1957, and as published in a recent issue of the journal of the Florida Society of Engineers. However, we believe that the substitution of the word "systematized" for the word "standardized" would more clearly express the intent and purpose of the paper. There is, as yet at least, no accepted standard form for this type of computation, and there is no intention on the part of SURVEYING AND MAPPING to present this particular paper in a light other than as the considered opinion of the author and his associates. The time will probably never come when this type of computation is "standardized"—in the sense that *all* must follow the prescribed routines. The methods outlined are perhaps "standard" for the office with which the author is associated, but they are not "standard" in the general sense, because the system described is by no means the only workable system in use.

Also we would like to make it clear that the printing plates (Figs. 1–7, inc.) are the same ones used in the publication of the paper by the Florida Society of Engineers. The cooperation of the editor of their journal has spared SURVEYING AND MAPPING the quite considerable expense which would have been incurred otherwise for the production of these seven printing plates. —EDITOR

TODAY, the demand for engineers and surveyors is far greater than the supply; therefore, it behooves us to utilize their talents as effectively as possible. We need to free these men from the tedium of manipulating figures in order that their time may be devoted to planning, design, research, etc. Recent technological advances have made electronic computers invaluable tools to the profession and their use in all types of engineering calculations is widespread. Traverses, inverse computations, and intersection problems can be rapidly and accurately solved by computers, e.g., the IBM 604, IBM 650, UNIVAC 120, UNIVAC File Computer, Monrobot, and Datatron. The following quotation from a letter by John A. Morin, Superintendent of Streets and Ex-Officio City Engineer, City of Oakland, California, illustrates their acceptance.

"The City of Oakland has been fortunate in making arrangements with the California Division of Highways for the use of their electronic equipment for traverse computations. . . . The time required to set up and run traverse computations on conventional calculating equipment has been a considerable drain on engineering manpower and it, therefore, is gratifying to have the use of this electronic equipment made available to us."

Presented at the Seventeenth Annual Meeting of the American Congress on Surveying and Mapping, Washington, D. C., March 6–8, 1957.

Obviously, computers cannot always be justified nor are they always available to private firms and local governments. We hope this paper, relating to necessary calculations for record plats of subdivisions, will stimulate interest in standardizing and simplifying procedures for surveying and mapping. Many of the forms and procedures are also adaptable to other plane surveying problems. The author believes that engineers and surveyors will find suggestions herein which will save them time and money in their daily work. These savings may be effected in one or more of the following ways:

1. Systematic procedures throughout larger offices enable personnel to work with notes of others as easily as with their own.
2. Simplified approach to various problems produces more efficient operators. Training time is reduced. Operators with less technical background may be taught more successfully than before.
3. Organized work simplifies checking and filing for future references.

This work is limited to elementary formulas to which most of you were exposed in first year high school. No new theories will be propounded, only the basic equations for plane triangles and circular arcs. We are seeking here to eliminate scratch notes which are later lost or discarded. At the same

time, we want to keep every step of every calculation written down where it can always be found quickly. It is the author's desire that suggestions be forwarded to him for study and incorporation in a future publication of this discussion. In this way, all of us can learn from each other.

STANDARDIZED COMPUTATIONS

1. *Traverses*

Two types of traverses are dealt with in this work, field (or actual) and theoretical. Both are computed on the standard Traverse Sheet. (Figs. 2, 3, and 5.) Traverses composed of field measurements are subject to adjustment in order to secure mathematical closure. The field traverse should be measured over permanent monuments and should close within the prescribed limits of error. Adjustment is made in the office by the operator according to the method of his choice. This author prefers a "Semigraphic Adjustment for Street Centerline Surveys" as presented by H. L. Thomson, Los Angeles Department of Public Works, page 362, Vol. XIII, SURVEYING AND MAPPING, July–September 1953. This method permits him to make adjustments in proportion to errors caused by variable lengths of sights, atmospheric conditions, inaccuracy of positioning sights and instrument, or other items noted by the field party, without changing observations believed to be more accurate.

Theoretical traverses, as here used, are based on perfect closures on a plane grid. Having made adjustments as mentioned above, all further calculations involve theoretical traverses. Thus, we see that the majority of office work will be of this latter type. The author has made informal time and motion studies in various offices during the last six years and presents on these pages the end results. No single suggestion shows outstanding merit, but adoption of the complete system has invariably proved effective.

2. *Basic Layout*

First, we lay a grid on the proposed plan of the subdivision. An overlay may be used for this if desirable. After a careful study of the plan, the main streets are laid in first by means of whatever control is available. Curve P.I.'s are assigned coordinates. Bearings of lines are calculated roughly by inverse computation. Slight adjustments are then made where possible to simplify final calculations. For example, if street bearings can be assigned as whole degrees and minutes, functions are more easily located in the tables. If it is necessary to use seconds in the bearings of streets, we should try to use *even* integers. Then functions of $\Delta/2$ will never require interpolation. Rarely will it be necessary to lay street lines to the refinement of 1/10 second.

Caution exercised in the basic layout will pay off all through the job. For example, try to avoid unnecessary property pins. They require extra work in both office and field. Wherever possible, the beginning or end of a curve should also be a lot corner. Unless local regulations state otherwise, short tangents between curves, compound or reverse, and at intersections are avoided. If the planner's drawings permit, curves for parallel streets are made concentric. Then if lot sidelines are radial, calculations are simplified. If utility engineers have no serious objections, back lines are sometimes made concentric with street lines, further simplifying the work. If chords must be used, symmetry of plan will reduce work slightly.

3. *Block and Lot Calculations*

Any secondary streets not laid out previously are placed as shown on the plan. The author then sets up two series of calculation sheets. The first refers to each block by number; the other series contains curve calculations, also arranged numerically. As in subsequent examples, descriptions of stations are systematically abbreviated to save space and avoid confusion. Usually it is better to complete all curve sheets first if possible. Any unknown items may then be obtained as the respective block calculations are made.

4. *Basic Elements and Aids*

A. *Calculating Machine.* An electric desk calculating machine is the basic time-saver essential to following the suggestions herein. No attempt is made to recommend the use of one machine rather than any of

its competitors. However, the author feels that it is necessary to treat specific cases in a specific way, not to refer to actual examples by speaking in generalities. Because of his familiarity with the Model 8N–213 as manufactured by the Monroe Calculating Machine Company, Inc., the author has obtained permission to refer to operations on this machine. Readers using other machines will find minor variations necessary from time to time; some may be simpler than shown here, others more cumbersome.

B. *Azimuths (Bearings) of Lines.* Directions of lines are noted as azimuths and are measured clockwise from Grid South. Azimuths greater than 180° are generally reduced by 180°. In a plane coordinate system, the azimuth and back azimuth of any line differ by exactly 180°. The smaller number is easier to use.

Bearings in the southwest or northeast quadrants have the same value as azimuths. Bearings in the northwest or southeast quadrants are subtracted from 180° to be noted properly as azimuths.

A ten-bank machine permits addition or subtraction of degrees, minutes, seconds, and tenths of seconds by pointing off as below.

10 9 8	7 6 5	4 3 2 1
1 7 9	0 5 9	0 6 0.0
Degrees	Minutes	Seconds

Example: 123° 45′ 67″.8 would appear in lower dials as: 1230450678. To reduce to proper designation, add 9400; result: 1230460078, indicates 123° 46′ 07″.8. The "94" constant corrects decimal dials for sexagesimal arithmetic. 9400000 or 9400 is inserted to reduce minutes or seconds, respectively; adding if last machine operation was addition, subtracting if subtraction.

Angles at stations along a traverse are measured clockwise from backsight to foresight. Azimuths are carried forward simply by adding the angles in turn, adding the "94" constant as required, and subtracting 180° when necessary.

Note that at any station the azimuths of two courses differ by the amount of the included angle. If rotation is clockwise, addition is indicated; if counterclockwise, subtraction. If subtraction results in a negative remainder, simply add 180°.

The method outlined above permits all angular addition and subtraction on the machine with maximum efficiency. It eliminates need for noting a bearing on scratch paper, and then subtracting. Even more important, it streamlines the thought patterns of the operator. He can watch the more important parts of his work, by remembering only that *clockwise* is ALWAYS PLUS.

The only disadvantage seen in this procedure is that the finished plat usually must be noted with bearings rather than azimuths. However, all azimuths less than 90° are shown immediately as S–W or N–E. Azimuths greater than 90° are subtracted from 1790590600 and shown on the plat as N–W or S–E.

C. *Trigonometric Functions.* "Eight Place Table of Trigonometric Functions for every Sexagesimal Second of the Quadrant" by Professor Dr. J. Peters, J. W. Edwards, Publisher, Inc., Ann Arbor, Michigan, is the "Bible" for the work at hand. It may be ordered directly from the publisher for $20.00, plus postage. "Natural Sines and Cosines to Eight Decimal Places," Special Publication No. 231, Department of Commerce, Coast and Geodetic Survey, is much cheaper, but does not contain the tangent functions necessary for inverse computations.

In using azimuths rather than bearings, we have need for trigonometric functions from 0° to 180°. Peters reads only from 0° to 90°. Of course, it is possible to subtract 90° from any angle over 90° and use the opposite functions. But this simple operation actually defeats our purpose. It introduces an extra compulsion on the part of the operator. He must remember to do one way one time and another way next time. One set of reversed functions in the wrong spot would be far more costly than a slight revision of the book at the very outset of its use. Remember that we are seeking both efficiency and accuracy.

With the aid of a numbering machine, it is a simple job to add the proper degrees and

minutes at the head and foot of each column to bring the tables up to 180°. To obtain the correct figure in each spot, the author sets a six-place numbering machine to read

| | 9 | 0 | | 0 |

and to advance one number with each impression. He begins in the front of the book, in the lower left side of each column. As work proceeds, it is well to check the results. The number stamped should always exceed that at the top of the column by 90°. Passing 45° (stamping 135°), the work proceeds from the rear of the book to the front; results, which are now at upper right of each column, are checked against existing figure at foot of the same column. Upon reaching 59 minutes each time, it is necessary to *manually* return the first two spaces to the setting above and advance the degrees to the next unit.

The hypotenuse of a 4-inch 45° triangle makes an excellent guide to use on the pages of this book. With the triangle laid horizontally just below the correct second at left or right of the column (depending on location of degrees and minutes at head or foot), point to the correct function with the left index finger. If using all eight figures, enter the 3 digits at head or foot of column (watch for stars) and the first digit at index finger as a four-figure group. Then enter the remaining four digits as another group. Omit the initial zero and decimal ("comma" in Peters book) for sines and cosines. They are always implied and mathematically correct, but they are time consuming and unnecessary in our work. Now hold the triangle steady, shift the index finger to next function desired, and repeat.

The example and directions to be given are based on using three decimals for distances (thousandths of a foot). This assures platting to two decimals with excellent closure. Many curve radii or boundary lines will exceed 1000 feet. Thus, we are using a minimum of seven significant figures. (The City of San Francisco requires calculations to four decimals, a minimum of eight significant figures.) It, therefore, appears worthwhile to use all eight places of the functions as given. As the functions vary generally in the sixth digit for succeeding seconds, it will be seen that we must either interpolate to tenths or hundredths of a second or ignore the seventh and eighth digits as insignificant.

The best method is to hold our eight places in calculations but keep all possible lines to even seconds of azimuth. The only exceptions should be for land lines (and streets necessarily parallel or normal to them) or radii of very flat curves. Generally, interpolation to 1/10 second will be more than adequate for closure within 0.005 feet. It also permits free use of the machine for addition of azimuth as previously described. For azimuths which will be used often, the sine, cosine and tangent are often entered directly on the work sheet to facilitate future work.

D. *Tabular Forms.* Two sample forms are shown later and will be only briefly summarized here. It is hoped that your interest in this work will call for an expanded text, to include more forms and more complete explanations of their uses and advantages, at a later date.

1. *Traverse Sheet.* The Traverse Sheet for Plane Coordinate Computation (Figs. 2, 3 and 5.) lies at the heart of this whole discussion. As shown, it has a capacity of 38 stations and 37 courses, in addition to complete identification for permanent filing. You are expected to enter 8 digits in a space ¼″ by 1″. To some operators, this may seem cramped, but there is plenty of room if a sharp pencil is used. Remember that it is a real advantage to set out a traverse through 38 stations on one 8½″ × 11″ sheet. It takes less time for calculations, hunting in tables, and thumbing through files. Columns 2 and 3, 6 and 7, 8 and 9 have been *reversed* from the conventional arrangement for the following reasons:

(1) In the State Coordinate System, "X" generally precedes "Y."
(2) In the tables, sine precedes cosine.
(3) "Departure" divided by "Latitude" equals "Tangent" of the Azimuth.

Columns 4 through 9 are staggered one-half space vertically because they are related, not to the stations themselves, but

rather to the lines between the stations. An operator familiar with this form can find and enter information more quickly and accurately, in the author's opinion, than is possible on some other designs.

2. *Curve Sheet.* The Curve Sheet for Subdivisions (Figs. 6 and 7.) was adopted to supply information which cannot readily be entered on the Traverse Sheet. As a supplement to this discussion, a portion of a subdivision work sheet has been prepared. Curves 2 and 3 have been calculated as examples. Full explanation of the Curve Sheet is included on the samples.

E. *Standard Problem Solutions.*

1. *Inverse Computation.* Traverse Sheet, Page 1 (Fig. 2.) shows two examples of this problem on the first four lines. To begin, enter station identification in column 1. Any stations which are not otherwise

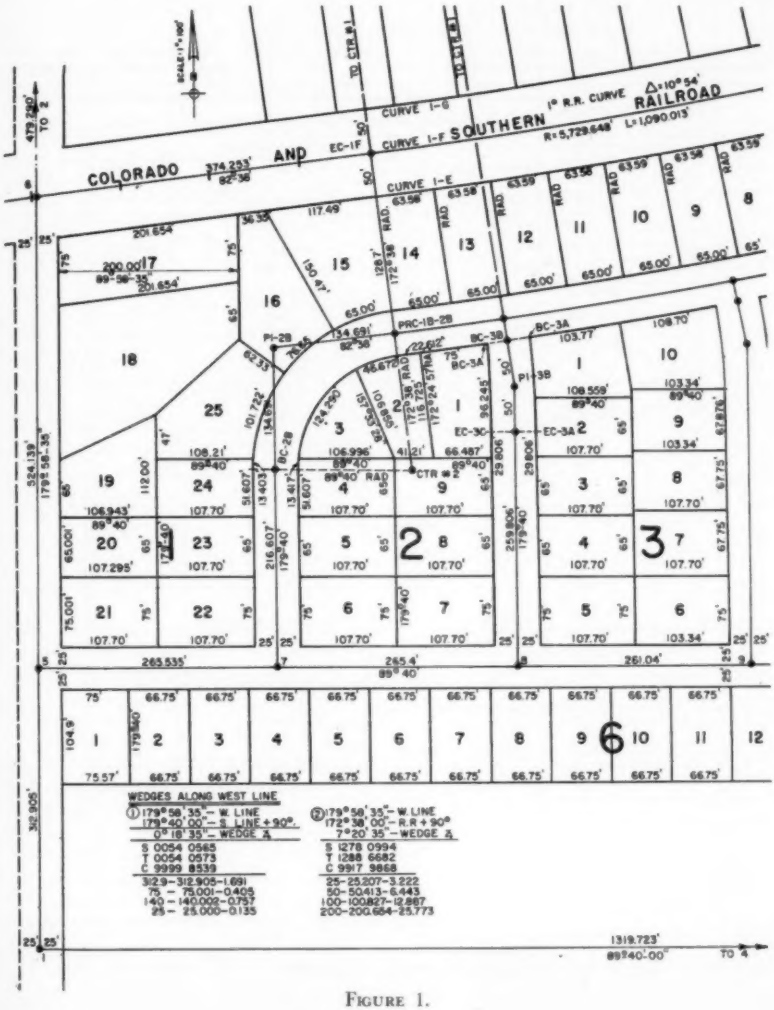

FIGURE 1.

readily identified have been assigned numbers. In the first example, we are seeking the distance and azimuth between the two boundary corners 1 and 2. Enter their coordinates as shown. By subtraction, obtain departure and latitude for entry in columns 8 and 9 together with algebraic signs. On the machine, set for 3 decimals on the keyboard and 9 decimals on the upper dials. Use Divident Alignment key. Set 0.542 on keyboard, depress Enter Dividend. Set 1316.334 on keyboard, depress Divide. Read tangent 0.00041175 on Upper Dials. Note that negative tangent denotes azimuth greater than 90°. From tables, enter azimuth 179° 58′ 35″, sine 0.00041209, and cosine 0.99999992. Ignoring decimals on machine, set larger coordinate difference (1316.334) from left side of Keyboard. Depress Enter Dividend. Set corresponding

TRAVERSE SHEET
PLANE COORDINATE COMPUTATION

STATION	COORDINATES "X" EAST		"Y" NORTH		DISTANCE		AZIMUTH			SINE		COSINE		DEPARTURE			LATITUDE		
1	2		3		4		5			6		7		8			9		
1	2450	972	3129	836			°	′	″										
2	2450	430	4446	170	(1316	334)	179	58	35)	0004	1209	9999	9992	−	0	542	+	1316	334
4	3770	673	3137	513						TAN = −		00004	1175						
1	2450	972	3129	836	(1319	723)	(89	40	)	9999	8308	0058	1773	−	1319	701	−	7	677
										TAN = +		171.	903217						⊙
1	2450	972	3129	836															
5	245	843	3442	741	312	905	179	58	35	0004	1209	9999	9992	−			+		
6	2450	627	3966	880	524	139								−			+		
2	2450	430	4446	170	479	290								−			+		
6	2450	627	3966	880															
EC-1F	2821	791	4014	866	374	253	82	38		9917	4592	1282	1864	+			+		
CTR 1	2087	143	9697	221	5729	648	172	38						−			+		
PRC 1B-2B	2847	909	3812	848	5933	348								+			−		
PI-2B	2714	330	3795	578	(134	691)	82	38		9917	4592	1282	1864	−			−		
7	2716	374	3444	286	(351	298)	179	40		0058	1773	9999	8308	+			−		
5	2450	843	3442	741	INT	∠ =	97	02		9924	7508			−	131	535	−	368	562
⑦	2716	374	3444	286	265	535	89	40		9999	8308	0058	1773	+			+		
8	2981	769	3445	830	265	400								+			+		
9	3242	805	3447	348	261	040								+			+		
7	2716	374	3444	286															
BC-2B	2715	114	3660	889	216	607	179	40						−			+		
CTR 2	2867	441	3661	776	152	330	89	40						+			+		
PRC	2847	909	3812	848	152	330	172	38		1282	1864	9917	4592	−			+		
CTR 1	2087	143	9697	221															
PI-3B	2979	967	3755	631	6008	296	071	27	15	1485	9846	9888	9762	+			−		
8	2981	769	3445	830	(309	806)	179	40		0058	1773	9999	8308	+			−		
PI-3B	2979	967	3755	631	INT	∠ =	− 8	12	44	1428	4282			+	894	626	−	6251	391
BC-3B	2972	537	3805	076	50	000	171	27	16	1485	9573	9888	9803	−			+		
CTR 3	2283	776	3701	580	696	494	81	27	16					−			−		
EC-3B	2980	258	3705	632	696	494	89	40		9999	8308	0058	1773	+			+		
8	2981	769	3445	830	259	806	179	40						+			−		

BY NW DATE 1-27-55 DESCRIPTION BOUNDARY, STREETS, CURVES JOB 551 PAGE 1

FIGURE 2.

function (0.99999992) on keyboard. Depress Divide. Enter 1316.334 in column 4 from upper dials, pointing off by inspection. Set distance (1316.334) on keyboard, using three decimals and press Enter Multiplier. Set unused function (0.00041209) on keyboard, using 8 decimals, and press Clear Multiply. The product (0.542) on lower dials (11 decimals) shows check on all work after subtraction of original coordinates.

2. *Direct Computation: Traverses.* If both distance and azimuth from a known to an unknown point are given, it is a simple operation to arrive at the missing coordinates. The conventional method is to use the distance as a constant multiplier, obtaining latitude and departure upon Clear Multiplying with cosine and sine in turn. Coordinates are then obtained by addition and/or subtraction, beginning from the

TRAVERSE SHEET

PLANE COORDINATE COMPUTATION

STATION	COORDINATES "X" EAST	COORDINATES "Y" NORTH	DISTANCE	AZIMUTH ° ' "	SINE	COSINE	DEPARTURE	LATITUDE
1	2	3	4	5	6	7	8	9

THE INTERSECTION PROBLEM - USING PROPOSED TRAVERSE FORM

The examples on this page and next are taken directly from Vernon D. George's paper as presented in 1955. No formulas or explanations will be given here, only the routine.

CASE I. INTERSECTION OF TWO STRAIGHT LINES

GIVEN: Two straight lines having known azimuths and passing through known points.

REQUIRED: Coordinates of the intersection and distance on each line to the known point.

(1) Enter on form as below all information necessary to a correct solution.

PRC	2847	909	3812	848	(	)	82	38	00							
PI-2B																
7	2716	374	3444	286	(	)	179	40	00							

(2) Subtract one azimuth from the other to obtain the Intersection Angle. From the tables, enter its Sine and the Sine and Cosine of the two known azimuths. Indicate the algebraic signs of the corresponding Departures and Latitudes.

PRC	2847	909	3812	848	(	)	82	38	00	9917	4592	1282	1864	-			-	
PI-2B																		
7	2716.	374	3444	286	(	)	179	40	00	0058	1773	9999	8308	+			-	
					INT. ∠	→	97	02	00	9924	7508							

(3) Subtract X and Y coordinates of first station from those of third station and enter as Departure and Latitude on same line as Intersection Angle. Lay a 1/4" x 5" metal guide in the position indicated. Four signs remain exposed. An odd number of like signs indicates "Plus", an even number indicates "Minus". Place the sign obtained in the space to left of guide. Set Keyboard at 10 decimals for functions and 6 for distances, lower dial and upper dial at 6. Multiply as indicated by numbered arrows. Set 131.535 on Keyboard. Press "Enter Multiplier". Set 0.99998308 on Keyboard. Press "Clear Mult." Set 368.562. Press "Enter Mult." Set 0.00581773. Press ACC Mult. Set 0.99247508. Press Div. Read 134.691 on Upper Dials. Enter at left end of guide.

															ACC	MULT.		
PRC	2847	909	3812	848	(134	691	)											
PI-2B																		
7	2716	374	3444	286	(	)	179	40	00	0058	1773	9999	8308	+			-	
					INT. ∠	→	97	02	00	9924	7508				-	131	535	- 368 562
					③	KEYBOARD												
					④	DIVIDE									CLEAR	MULT.		

(4) Repeat above procedure with guide over second line. Note that second step is Negative Multiplication, with steps reversed to avoid a negative result on Lower Dials. Division is facilitated by using DIVD ALIGN key and depressing Tab Stop 7 or 8.

															CLEAR	MULT.		
PRC	2847	909	3812	848	(134	691	)	82	38	00	9917	4592	1282	1864	-			
PI-2B					(351	298	)											
7	2716.	374	3444	286	INT. ∠	→	97	02	00	9924	7508	NEG. MULT.			-	131	535	- 368 562
					③	KEYBOARD						②						
												④	DIVIDE					

(5) Calculate coordinates of Intersection by Traverse Computation from first through third point. This has been done on Line 12, Page 1.

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				INTERSECTION OF TWO STRAIGHT LINES	551	1-A

FIGURE 3.

known coordinates. Some readers may not have considered the saving in time which can be effected by using cumulative multiplication. In the example given above, let us assume we are checking the work of another operator. We accept the distance (1316.334) and azimuth (179° 58′ 35″) temporarily as correct. From tables check sine (0.00041209) and cosine (0.99999992). Azimuth from 1 to 2 is almost north, latitude is plus. Lying between 90° and 180° indicates opposite (minus) sign for departure.

Depress Tab Stop 9. Set 8 decimals on keyboard for functions, 3 for distances. Set 11 decimals on lower dials. Set 2450.972 on keyboard, depress Enter Dividend. Set 1316.334 on keyboard, depress Enter Multiplier. Set 0.00041209 on keyboard, depress Negative Multiply. Read "X" coordinate

PLANE COORDINATE COMPUTATION

STATION	COORDINATES "X" EAST	COORDINATES "Y" NORTH	DISTANCE	AZIMUTH	SINE	COSINE	DEPARTURE	LATITUDE
1	2	3	4	5 ° ′ ″	6	7	8	9

CASE II. INTERSECTION OF A STRAIGHT LINE AND A CIRCULAR ARC

GIVEN: A straight line of known azimuth passing through a known point. A circular arc of known radius and center intersecting the straight line.

REQUIRED: Coordinates of one of the points of their intersection. Distance on the straight line from known point to intersection. Azimuth from center to point of intersection.

(1) As in Case I, enter as below all necessary information.

CTR.1	2087	143	9697	221	6008	296	(		)					
PI-3B					(		)	179	40					
8	2981	769	3445	830										

(2) Enter Sine and Cosine of known azimuth and algebraic signs of Departure and Latitude. Again, determine net Departure and Latitude from first to third station.

CTR.1	2087	143	9697	221	6008	296	(		)					
PI-3B					(		)	179	40	0058	1773	9999	8308	+
8	2981	769	3445	830									+	894 626 - 6251 391

(3) Lay metal guide opposite known distance, cross multiply as indicated by arrows, and divide by the known distance to obtain Sine of the Intersection Angle. Upper dials are set at 10 decimals, all other decimals as before.

CTR.1	2087	143	9697	221	③ KEYBOARD					④ DIV.			② NEG. MULT.	
PI-3B					6008	296								
8	2891	769	3445	830	(		)	179	40	0058	1773	9999	8308	+
						⑤ ANSWER →				1428	4282	CLEAR MULT.	+	894 626 - 6251 391

(4) From tables, enter Intersection Angle and add or subtract to obtain azimuth of radius. Check working drawing carefully. Wrong choice of sign will result in solution of wrong Intersection Point. From tables enter Sine and Cosine of this azimuth, with algebraic signs as shown. Move guide to other line and again multiply as indicated. Divide by Sine of Intersection Angle to obtain Distance at end of guide. (Six decimals on Upper Dials). In this example, angular measure was carried to 1/100 second to prevent cumulative errors along the 6000′ radius curve. Rounding off to whole seconds resulted in an error of 0.04′ in arc of Lot 2, Block 2.

CTR.1	2087	143	9697	221								① CLEAR MULT.		
PI-3B					6008	296	(171	27	15″	1485	9846	9888	9762	+
8	2981	769	3445	830	(	309	806							
					INT. 4 →		- 8	12	44″	1428	4282	NEG. MULT.	+	894 626 - 6251 391
							③ KEYBOARD					②		
							④ DIV.							

(5) Perform traverse calculations to obtain missing coordinates and check work as on Line 23, Page 1.

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FIGURE 4.

of station 2 on lower dials as 2450.430. Repeat this procedure for "Y" coordinate, using Accumulative Multiply as indicated by plus sign for latitude. Arriving at coordinates given for station 2 indicates complete check.

Third example on Page 1 (Fig. 2.) shows method of obtaining coordinates of two points on line 1–2. Arrow in azimuth column denotes repetition.

At the option of the operator, the functions may be set as constant multipliers, entering the distances in turn.

Leaders from functions to small circles enable the operator to use functions repeatedly without wasting time rewriting them or risking errors in copying. Note that azimuths differing by 90° are more easily recognized or entered than if bearings were used. Crossed leaders indicate re-

TRAVERSE SHEET
PLANE COORDINATE COMPUTATION

STATION	COORDINATES "X" EAST	COORDINATES "Y" NORTH	DISTANCE	AZIMUTH	SINE	COSINE	DEPARTURE	LATITUDE
1	2	3	4	5	6	7	8	9
				° ' "				
EC-3B	2980 258	3705 632	25 000	89 40			+	+
EC-3A	3005 258	3705 777	35 194	179 40			−	+
3-1S	3005 053	3740 971	(0 859)	89 40 00	9999 8308	0058 1773	−	−
3-1SW	3004 194	3740 966	721 494	(86 52 14²)	9985 0888	0545 8954	−	−
CTR.3	2283 776	3701 580	INT ℄ =	− 2 47 45²	0487 7953		− 721 277	− 39 391
BC-2B	2715 114	3660 889	25 000	89 40			+	+
BC-2C	2740 114	3661 034	13 393	179 40			−	+
2-3SX	2740 036	3674 427	(0 704)	89 40 00	9999 8308	0058 1773	+	+
2-3SW	2740 740	3674 431	127 330	(95 42 14)	9950 4883	0993 8729	+	−
CTR.2	2867 441	3661 776	INT ℄ =	+ 6 02 14	1051 7548		+ 127 405	− 12 651
CTR.2	2867 441	3661 776	127 330	151 37 54	4751 3797	8799 1131	−	+
2-2NW	2806 942	3773 815	(106 855)	(157 33 28)	3817 5159	9242 6497	+ 40 792	− 98 762
2-2SW	2847 734	3675 053	106 996	89 40	9999 8308	0058 1773	−	−
2-3SW	2740 740	3674 431	[TRAVERSE DOWN TO	2-2NW, UP TO	2-2SW]		TAN. =	− 4130 3335
2-2SW	2847 734	3675 053	(41 213)	89 40	9999 8308	0058 1773	+	+
2-1SW	2888 946	3675 293	(6075 073)	172 24 57	1319 8247	9912 5205	−	+
CTR.1	2087 143	9697 221	INT ℄ →	82 44 57	9920 0311		− 760 591	+ 6022 168

BALANCE OF BLOCK 3 DEPENDS ON NEXT CURVE SHEET.

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FIGURE 5.

versed functions for perpendicular lines.

Accumulative (or Negative) Multiplication results in better closures because none of the 11 decimals is lost during the procedure. This is most apparent when traversing with identical distances along a straight line.

Wherever possible, traverses are set up from one known point to another. Second choice is a closed traverse. Coordinates of both known stations are entered before beginning. Closure is indicated by a check mark for identical value. Any deviation is noted by writing and circling all numerals in answer not identical to predetermined value. For example, on Line 22, Page 1 (Fig. 2.) the 10 circled in column 2 indicates closing answer to be 2847.910, 0.001 greater than correct value. Some readers may find it preferable to write +1 (or −1).

CURVE SHEET FOR SUBDIVISIONS
RADIUS DEFINITION

	"A" CURVE OUTSIDE	"B" CURVE CENTERLINE	"C" CURVE INSIDE
Δ	82° 58' "	° ' "	° ' "
L/R	1.4480 4151		
R	177 330	152 330	127 330
T	----------	134 691	----------
L	256 781	----------	184 379

SKETCH

RADIAL AZIMUTH	CENTRAL ANGLE	RADIANS (L/R')	ARC LENGTH	LOT NO. (OR STREET)
89° 40' 00"	° ' "			
93 59 50	4 19 50	0755 8246	13 403	1-24
126 51 50	32 52 00	5736 3155	101 722	1-25
151 37 54	24 46 04	4322 7927	76 656	1-16
172 38 00	21 00 06	3665 4824	65 000	1-15
	1 4480 4151	①	256 781	2A TOTALS
89 40 00				
95 42 14	6 02 14	1053 6941	13 417	2-4
151 37 54	55 55 40	9761 2387	124 290	2-3
172 38 00	21 00 06	3665 4823	46 672	2-2
	1 4480 4151		184 379	2C TOTALS

SCRATCH

T = R TAN Δ/2 ⌐ L = R(L/R)

41° 29'

134.691 = R(6842 0682)

PAGE 1, LINE 12

INSTRUCTIONS FOR USE OF CURVE SHEET

Curves in subdivisions are calculated along property lines. Information along centerlines or offset "range lines" is sometimes also required. This form assumes 3 curves: Outside, Centerline and Inside. The B. C. (Beginning of Curve) is always placed at the end which establishes a deflection angle to the right. Then the azimuths of Radii or Chords increase as we proceed toward the E. C. (End of Curve). Preliminary calculations are made as required to complete blanks in the upper left portion of the form. A sketch is not generally needed for these calculations, but space is provided for unusual arrangements. (See Sheet for Curve No. 3.) Most calculations are made on the machine and entered in spaces provided, but occasional formulas and substitutions may be noted in the "Scratch" spaces.

The last 5 columns reach full height of sheet and are designed to assist in calculating and preserving elements of the various arcs as subtended by lot lines. We may work from left to right or from right to left, depending on the design criteria. In this example, Lot 15 of Block 1 (1-15) is set at 65,000. All other lot lines are determined by the radial azimuth. Note that radians may not check in some cases when working from known arc lengths. Obtaining the nearest second without interpolating forces us to "throw away" a maximum of 0.00000242 radians for each such arc.

BY H.W. | DATE 1-27-55 | CURVE NUMBER 2 | JOB 551 | PAGE C-3

FIGURE 6.

3. *Intersection Problems.* It is always possible to complete a traverse through three points if not more than two elements are missing.

CASE I. Both distances are unknown. This is actually the intersection of two straight lines and is fully explained on Page 1A. (Fig. 3.)

CASE II. Distance on one line and azimuth of the other are unknown. We solve for one of two intersections of a straight line and a circle (or circular arc). See explanation on Page 1B. (Fig. 4.)

CASE III. Both azimuths are unknown. This involves one of two intersections of two circles. By inverse computation, calculate distance and azimuth between the centers of the circles. Using the Law of Cosines as shown in Diagram No. 19, "Trigonometric Functions" (Form 359-S

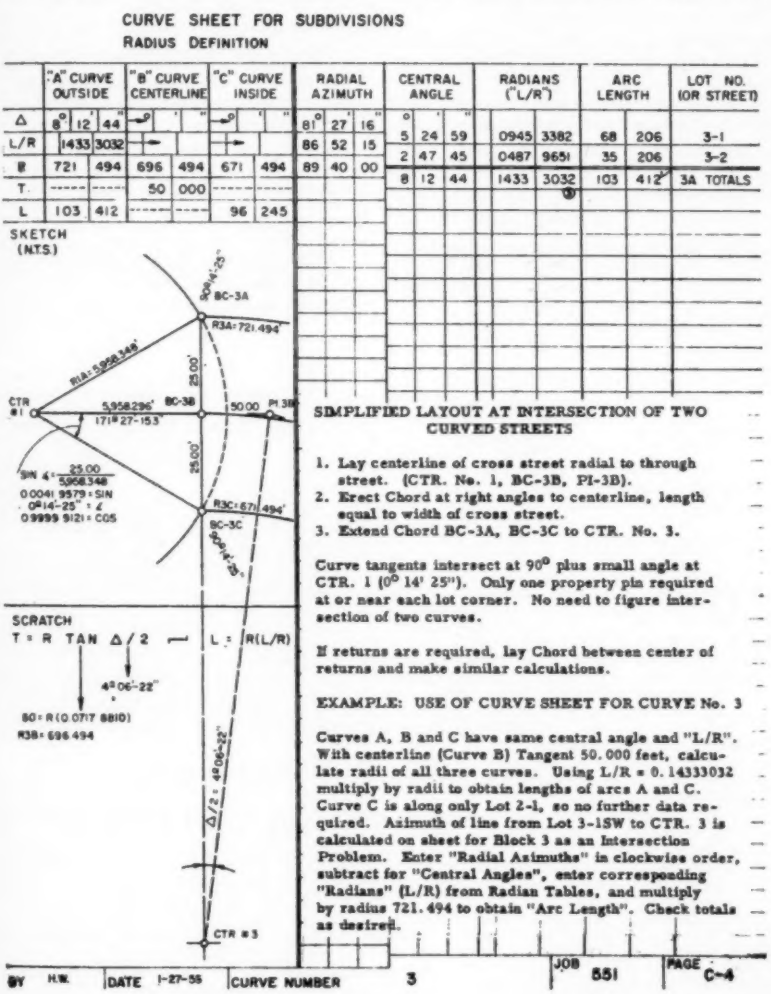
CURVE SHEET FOR SUBDIVISIONS
RADIUS DEFINITION
"A" CURVE OUTSIDE
"B" CURVE CENTERLINE
"C" CURVE INSIDE
RADIAL AZIMUTH
CENTRAL ANGLE
RADIANS ("L/R")
ARC LENGTH
LOT NO. (OR STREET)
Δ 8° 12' 44"
L/R 1433 3032
R 721 494 696 494 671 494
T ----- ----- 50 000 ----- -----
L 103 412 ----- ----- 96 245
81° 27' 16"
86 52 15
89 40 00
5 24 59 0945 3382 68 206 3-1
2 47 45 0487 9651 35 206 3-2
8 12 44 1433 3032 103 412 3A TOTALS
SKETCH (N.T.S.)
BC-3A
R3A=721.494'
R1A=5958.348'
25.00'
CTR #1
5958.296'
BC-3B
50.00 PI 3B
171° 27' 15.3"
SIN 4° 25.00 / 5958.348
0.0041 9579 = SIN 0°14'-25" = Δ
0.9999 9121 = COS
R3C=671.494'
BC-3C
SCRATCH
T = R TAN Δ/2
L = R(L/R)
4° 06'-22"
80 = R(0.0717 8810)
R3B=696.494
Δ/2 = 4° 06'-22"
CTR #3
SIMPLIFIED LAYOUT AT INTERSECTION OF TWO CURVED STREETS
1. Lay centerline of cross street radial to through street. (CTR. No. 1, BC-3B, PI-3B).
2. Erect Chord at right angles to centerline, length equal to width of cross street.
3. Extend Chord BC-3A, BC-3C to CTR. No. 3.
Curve tangents intersect at 90° plus small angle at CTR. 1 (0° 14' 25"). Only one property pin required at or near each lot corner. No need to figure intersection of two curves.
If returns are required, lay Chord between center of returns and make similar calculations.
EXAMPLE: USE OF CURVE SHEET FOR CURVE No. 3
Curves A, B and C have same central angle and "L/R". With centerline (Curve B) Tangent 50.000 feet, calculate radii of all three curves. Using L/R = 0.14333032 multiply by radii to obtain lengths of arcs A and C. Curve C is along only Lot 2-1, so no further data required. Azimuth of line from Lot 3-1SW to CTR. 3 is calculated on sheet for Block 3 as an Intersection Problem. Enter "Radial Azimuths" in clockwise order, subtract for "Central Angles", enter corresponding "Radians" (L/R) from Radian Tables, and multiply by radius 721.494 to obtain "Arc Length". Check totals as desired.
BY H.W. DATE 1-27-55 CURVE NUMBER 3 JOB 551 PAGE C-4

FIGURE 7.

Revised), Monroe Calculating Machine Company, Inc., solve for the angles of the triangle formed by the line of centers and the two radii to the point of intersection. Then by direct traverse through first center, intersection point, and second center, obtain the coordinates of the intersection. This problem does not lend itself to standardized computations. Curve Sheet No. 3 demonstrates one way to avoid it.

Perfect Title

The Post Office Department at Washington, making a careful investigation of the titles to proposed post office sites in Louisiana, received title proof as far back as 1803, but, not satisfied, wrote for evidence as to prior titles. An attorney replied:

"I note your comment upon the fact that the record of title sent you as applying to lands under consideration, dates only from the year 1803, and your request for an extension of the record prior to that date.

"Please be advised that the Government of the United States acquired the Territory of Louisiana, including the tract to which your inquiry applies, by purchase from the Government of France in the year 1803.

"The Government of France acquired title by conquest from the Government of Spain; the Government of Spain acquired title by discovery of one Christopher Columbus, traveler and explorer, resident of Genoa, Italy, who by agreement concerning the acquisition of title to any lands discovered, traveled and explored under the sponsorship and patronage of Her Majesty, the Queen of Spain.

"The Queen had verified her arrangement and received sanction of her title by consent of the Pope, a resident of Rome, Italy, an ex officio representative and vice-regent of Jesus Christ.

"Jesus Christ was the Son and Heir Apparent of God. God made Louisiana.

"I trust this complies with your request."

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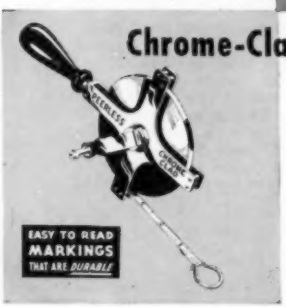

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Observers, Take Care

By ROY M. SYLAR

COAST AND GEODETIC SURVEY

IT IS TRULY SAID that a chain is only as strong as its weakest link. Such can also be said of a survey; it is only as strong, or accurate, as its weakest part. With the present-day need for precise control surveys, surveying and engineering organizations are being called upon more and more to make breakdowns from existing triangulation and traverses established by Federal or State agencies.

To make the breakdown, it is necessary to have proper instruments and to follow certain refinements in technique not required on ordinary surveying. In general, adequate instruments are provided because accurate surveys are seldom undertaken without direction theodolites and other precision equipment. However, poor observing techniques and the lack of knowledge of instrumental limitations still introduce the main weakness of most surveys. The purpose of this article is to present a short discussion on some of those observing techniques and instrument limitations.

As we all know, certain errors which are not compensated by procedure can enter into any observing program. These are target phase, parallax, and the vertical axis of the instrument not being vertical.

Refraction, another source of error, may be reduced by reobserving under more favorable atmospheric conditions. However, "abnormal refraction" is a much overworked excuse when the real fault may be poor observing techniques. A review of the observing program will sometimes clear up repeated refraction troubles.

Target phase may be minimized by erecting properly constructed targets with contrasting color bands which provide a satisfactory image for detecting phase-introduced shadows. Prior to proceeding with an observing program, the observer should always carefully inspect the targets, giving special attention to the alignment of contrasting bands. Broken alignment indicates target phase and the observer should proceed with caution, taking particular care to include the shadowed portion of the image in centering on the target.

Modern lightweight direction theodolites are particularly susceptible of getting out of level. No observing program will compensate for errors thus introduced. Good observing habits dictate repeated checks on the plate level and making the necessary adjustment at the close of each position if necessary. The importance of checking for this source of error cannot be overemphasized.

Checking and adjusting for parallax between the eye and the instrument crosshairs, and verniers, before beginning an observing sequence is essential for good observing. However, after the initial adjustment, this important source of error is frequently forgotten. Eye fatigue causes progressive change in the focusing of the eye and parallax may be introduced unnoticed. The habit of checking for parallax at least once or twice during the observing program will pay big dividends in the insurance of accuracy.

Short cuts to save a few minutes of a field party's time can be costly. Using a reduced number of circle settings when occupying a station with a direction theodolite is a sure way to reduce the accuracy of a survey. A direct and reverse pointing to each target on one setting of the circle is one position. Four such positions with a second-order theodolite is *not* considered second-order work; although such accuracy may sometimes be attained. The principal cost in occupying a station is transportation to the station and preparation at the site. Actual time consumed in turning angles with a direction theodolite is very small, being probably less than one hour for 8 positions over 5 lines from the occupied

station. The chance of reducing the accuracy of a survey by cutting the number of positions required to produce specified accuracies, when a few more minutes at the station will produce maximum results, is poor surveying economy. Claims to the contrary not withstanding, 8 positions with a second-order direction theodolite should be considered the minimum to obtain a value within second-order accuracy. Even with a first-order instrument, the minimum of eight positions should not be relaxed.

The exact centering of instruments and targets over stations is of prime importance. Eccentricities, if they are measured, are time consuming, both in the office and in the field, and could often be avoided. When it is considered that 1/40 or 0.025 foot is equal to one second of arc at the distance of one mile, it can readily be seen that poor centering, or inaccurate plumbing, over the point will result in surveys of questionable accuracy.

"Check angles", to an additional station, when taking off from an existing base, are good practice. This not only checks the observer's work, but also serves as positive identification of the base points. Many man-hours are lost each year because the positive positions of base stations were not verified prior to starting or tying in a survey.

Inspection of the instrument setup is an excellent habit. After the instrument has been centered and leveled over a station, it is good practice to move progressively around the tripod while checking the plate bubble for movement. Loose rocks, buried sticks, etc., transmitting movement through tripod legs have required many an expensive reoccupation of a station.

When attempting a precise survey, it is always better to aim for accuracies above the minimum requirement. A bit of practice, and care, will produce rewarding results in accurate dependable surveys. The small increase in time required to develop the essential habits of a "good" observer will pay off in the long run in both time and money; so why not "take care" now?

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New Design Features for the World Aeronautical Chart

By COLONEL RICHARD W. PHILBRICK

COMMANDER, AERONAUTICAL CHART AND INFORMATION CENTER

WHILE THIS MAY be an unusual method of introducing the subject of my paper, I would like to refer you to Figures 1 and 2 as a sort of before-and-after preview. Figure 1 is a picture of one of our first World Aeronautical Charts compiled and published early during World War II. Skipping a few years and a great deal of work, I am almost anxious for you to see the very latest in WAC design, our "New Look" WAC of 1957. (Fig. 2.)

By comparison, you might almost think that we have created not just new features but an entirely new chart! It depends upon the point of view. Actually, the change in design was not an instantaneous act like an explosion. Rather, it evolved in natural progressions through successive stages of improvement. This latest phase of chart design has by far been the most dynamic in the long history of the WAC series. We have met the most trying of our challenges with

Presented at the Seventeenth Annual Meeting of the American Congress on Surveying and Mapping. Washington, D. C., March 6–8, 1957.

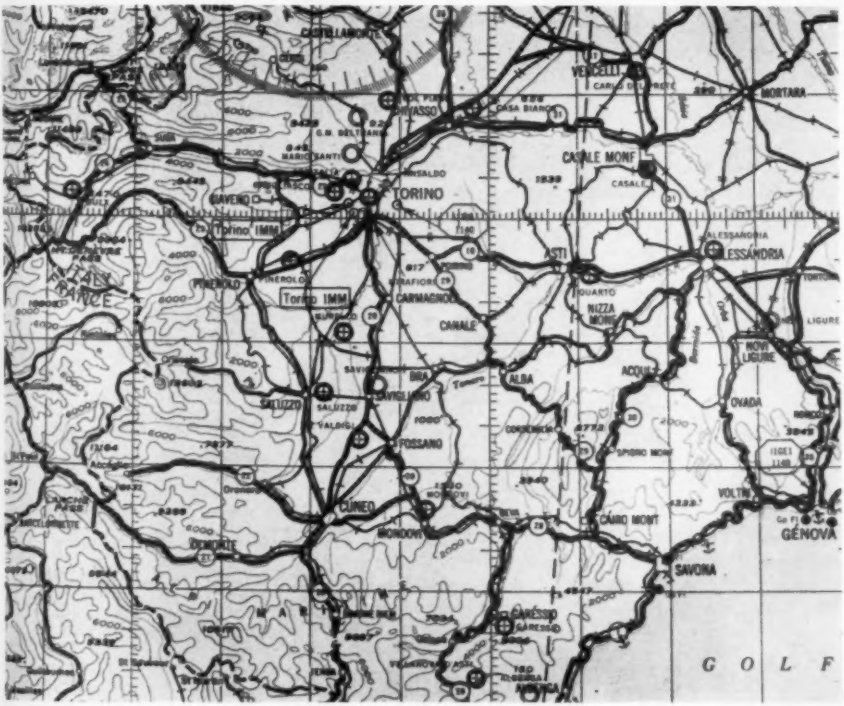

FIGURE 1.—World War II WAC.

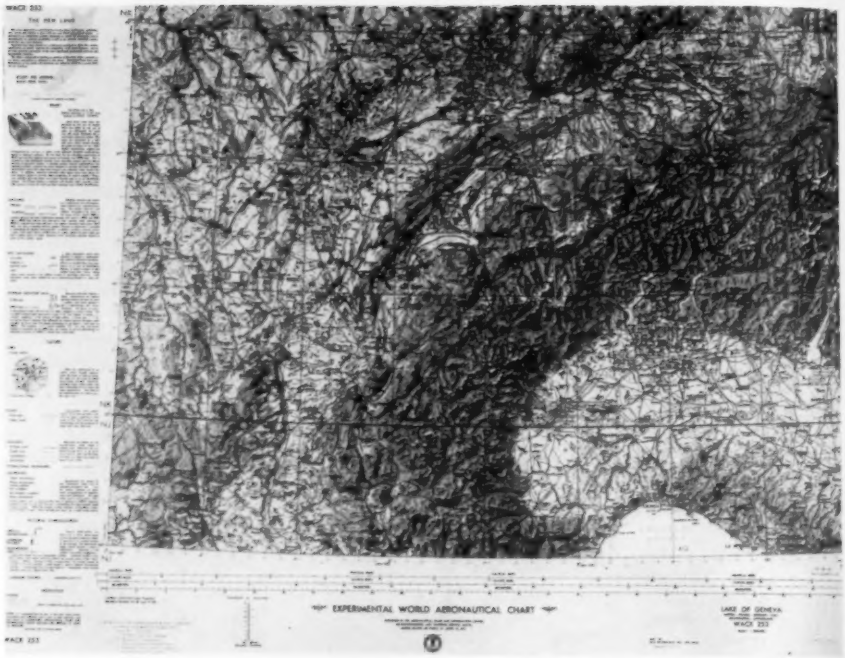

FIGURE 2.—"New Look" WAC of 1957.

new cartographic techniques, new concepts in chart design, and more advanced systems of chart evaluation. But before I describe our latest efforts to keep pace with today's needs, I would like, for several reasons, to take you back through some of the steps in the development of our primary navigation chart series: first, because the WAC is historically important, not only to the United States Air Force but to all aviation; second, because a brief review of former portrayals will more forcibly and clearly help explain the direction and intent of our new design characteristics; and finally, because I believe that a review of the WAC history will illustrate the constant need for cartographic innovation to keep pace with changed operational and environmental factors.

WAC HISTORY

In 1942, the principal charts or maps for use by the Air Force were Route Charts of the United States, a Western Hemisphere series of aeronautical charts produced for the Air Force by the Coast and Geodetic Survey, and International Maps of the World produced by the United States and certain other countries. These, of course, were somewhat duplicative in coverage and only partially covered important areas.

Based on operational needs of the time, the scale of 1:1,000,000 was determined the most appropriate for general in-flight use. For the main part of the earth's surface, the Lambert Conformal Projection was selected to maintain generally uniform scale and reasonable accuracy for plotting aircraft headings. The Mercator projection was chosen for a belt from the Equator to 4° north and south latitude. The Lambert projection was based on three separate cones from 4° to 72° latitude, with a polar stereographic projection for the polar caps. The sheet size was set at 22″ × 29″ based primarily on chart handling considerations and press size. This sheet size provided for chart detail at

the Equator in terms of an area of 4° of latitude and 6° of longitude. The sheet layout system retained the same 4° of latitude but provided for about the same detail per chart at all latitudes by increasing the longitudinal limits for the higher latitudes. At this point, it is appropriate to point out that the sheet-line layout permitted the best fit for a coordinated series for each land mass at the separate 4° latitude bands. Further, this sheet layout was conceived and designed as a master system within which charts at 1:500,000 scale could be produced as required.

I refer you again to our World War II WAC. (Fig. 1.) A little rough perhaps, but underneath the rather characteristic coarseness of detail and ruggedness are intriguing possibilities. Generalized terrain forms and elevation information were portrayed by gradient tints with a separate color between contour increments of 1,000, 2,000, 3,000, 5,000, 7,000, 9,000, 12,000, and 15,000 feet. At that time, with so many areas of the world uncharted and aircraft flying at medium altitudes, terrain heights were quite important. Note that culture and other checkpoint information was not particularly unlike the normal topographic map. Most of the World Aeronautical Charts produced in World War II were based on these design characteristics. During the War and slightly thereafter some radical design changes were considered internally within ACIC. However, many of these died on the vine, largely because we lacked the organization and system to develop and try them out.

Following World War II intensive design conferences took place at ACIC and included the user and the chart maker—both flying officers and cartographic personnel. Generally these efforts resulted in refinements and better organization of detail. (Fig. 3.)

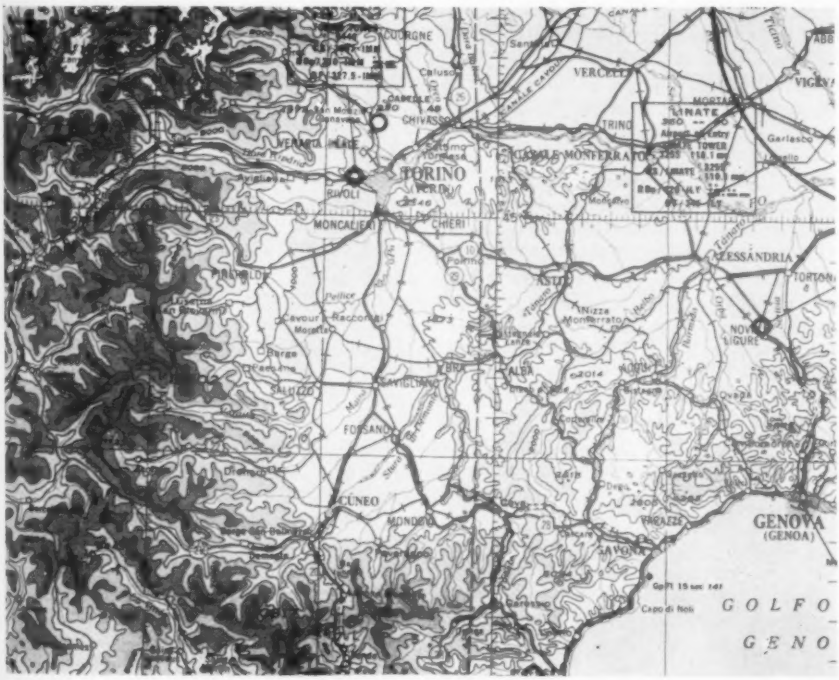

FIGURE 3.—1948 WAC.

A variety of improvements were introduced. Roads were changed from black to gray, urban areas were portrayed in yellow rather than the crosshatched black or gray, and gradient tints were slightly revised. Many chart features such as water courses, bridges, tunnels, etc., were subjected to refined symbolization. During this period, quality considerations began showing up in the design. These took the form of plus or minus signs on spot elevations, warning notices on the charts, golden buff tints for unreliable relief areas, and no tints at all where both the planimetry and relief were unreliable.

Based on military and civil requirements, a decision was made in 1947 to change the Lambert Projection cones. The problem was to reduce the major change in scale and severe rolling fit that existed at the break points between the Lambert cones at 28° and 48°. The decision was made to adopt a set of standard parallels for each 4° band of latitude and thereby spread out the change at break points to the individual fit between adjoining charts. This has proven to have some advantages and also some disadvantages. Not all of the charts of the WAC series have yet been converted for each 4° band of latitude.

In 1949 the first referencing system was included on the WACs other than the normal latitude and longitude designations. This was the World Geographic Referencing System, which is an adaptation of latitude and longitude aimed at reducing digits in referencing and providing a more orderly system of identifying locations on a worldwide basis. All WACs published since that time have included GEOREF.

In the period between 1949 and 1952, ACIC experienced considerable growing pains—not only did we grow in numbers, but our facilities expanded and, what is most important, the scope of our activities increased in keeping with the growth of our Air Force. During this period the WAC remained fairly stable in design but a more comprehensive collection and analysis of source material was accomplished, resulting in the production of better quality charts. It was a period of consolidation.

Early in 1952, however, we had established certain organizational components responsible for determining and investigating Air Force charting requirements, and for designing and developing new cartographic items. These segments formed what we call our "Problem-Solution" team in the field of design and development. Last year, in the Cartography Division of this meeting, we described this team. Briefly, we explained that the cartographic agency is faced with a tremendous challenge in the field of design. Major factors contributing to this challenge are advances in weapons systems, guidance systems, electronic aids to navigation, the speed of flight, and new flight altitudes varying from "on the deck" to over 40,000 feet. Added to these operational factors are production considerations, such as the availability and quality of information needed to make charts, new production techniques and materials, drastic limitations on production time, present and potential availability of skills, and of course the cost of providing the charts. These are only the main factors which promote the organized turmoil that we feel is both necessary and healthy.

We also explained that the initial staff responsibility for the investigation of user requirements is performed by the Requirements Division of the Directorate of Operations. Technicians and rated officers serve as the primary link between the chart user and the chart maker. They define Air Force cartographic requirements, isolate problems, and by their knowledge of the operational aspects and cartographic capabilities, establish characteristics for an experimental product. The second member of the team, the Specification and Techniques Office of our Production Plant operates within the framework provided by the Requirements Division in developing new techniques, portrayals, symbolization, and format for the finished products. These are tested by potential Air Force users and the results evaluated to determine how accurately the Requirements personnel have understood the problem and how closely the development personnel have supplied the answers.

Higher echelons in Air Force review our

cartographic solutions for conformance with Air Force objectives, and Air Force national and international policy considerations. The eventual approved item then joins the list of cartographic items the Air Force requires and is programmed for production in appropriate areas to an extent compatible with the other needs of the Air Force. This, of course, is an over-simplified analysis of the process, but it should help you to understand the procedures used in the basic development of suitable graphics.

Thus by 1953 we had established the machinery to set about transforming the WAC to meet the changing times. This was to be accomplished by a definite continued program of improvement, identified as the "Family of Charts Development Project." Its objectives were twofold: to improve the content and portrayal of our WACs, PCs, and ACs, and to standardize the portrayals and cartographic techniques between the various series as much as possible. This work has led directly to our newly designed World Aeronautical Charts. As features of the newly designed WAC are discussed in detail some of the development steps will be described and illustrated.

FACTORS AFFECTING DESIGN

Before I attempt to describe our new design, however, it would be appropriate to first review the major factors affecting this design. Extensive investigation by our problem-solution team revealed that the World Aeronautical Chart continued to be the primary chart used by our Air Force in routine peacetime operations. This includes short range military air transport, routine administrative flying, training of Air Force flying personnel, air defense training, etc. The actual wartime mission of this chart has changed considerably from World War II, in keeping with new aircraft and bombing tactics. In the strategic combat mission the World Aeronautical Chart comes into the picture primarily in the area several hundred miles from a chosen destination. Since most of the strategic striking force is now made up of high altitude jet aircraft operating at high speeds, the Jet Navigation Chart at a scale of 1:2,000,000 is ultilized as the primary chart for enroute navigation. In the tactical wartime mission the World Aeronautical Chart is still the primary chart for enroute navigation, just as it is the primary operational chart for air defense use in time of war. While military air transport has gone somewhat to the smaller scales such as 1:2,000,000, there is still considerable need for the WAC.

In considering user environment, we cannot overlook the very extensive use of the WAC in the intelligence community. While all kinds of information of military importance is analyzed, tabulated, etc., much of it is referred directly to the WAC. Many series of target charts and related items are identified by chart number with the WAC number making up part of the identification.

Probably the most significant operational factor that has come into being is the need for a graphic to permit aircraft to fly "on the deck" at high speed. This is such an important input to our present design that the nature of this kind of flight should be described. The mission is generally carried out at an altitude as close to the ground as possible for safe flight. This means a few hundred feet over relatively flat terrain and increasing naturally over more hilly and rugged terrain. Flights of this kind are accomplished at very high speed allowing only a split second for identification of a land mark to assure correct heading. The pilot finds it extremely difficult to scan his chart while in flight, necessitating very careful planning of the exact route to be followed and very careful study of the features that he would expect to see in flight. Also careful timing with respect to his position in flight is needed to be able to anticipate the recognition of a feature that he has studied.

Fortunately, many of the changes that we were considering in our Family of Charts Development relate very closely to fulfilling the detail needs that the low level flight seems to require. Our newly developed World Aeronautical Chart (Fig. 2) reflects new internal improvements combined with the present and future operational needs in which the low altitude flight requirements play an important part.

The principal things to note in this full chart view are the portrayal of land forms in shaded relief, the modification of the old gradient tint scheme, the addition of pictorial symbols for landmark and obstruction features, the appearance of contours, the addition of maximum elevation data, vignetted blue for water areas and an overall reduction in the line weights for transportation features. These are only examples of principal features to be described individually in more detail.

NEW FEATURES

To go first to the broad area of relief, prototype charts produced in the Alps-French Riviera region were the most instrumental in resolving the new approach to relief. Out of the many samples we produced during this experimentation, Sample chart No. 5 (Fig. 4) came more closely to the relief portrayal we considered to be the best solution.

In view of the low altitude flight requirement and the general need for improved relief portrayal, we chose the time-honored representation of land forms by shaded relief with the direction of light coming from the northwest. The work was actually accomplished with the aid of aerial photographs and maps with relatively close contour intervals.

While a single drawing seems to suffice for moderate relief, it was found necessary to include a relief cap drawing for accentuation of the higher mountain masses. Such drawings are generally made on vinylite with a lithographic pencil. The final printing over the shaded relief plate is made directly from a continuous-tone negative rather than a normal halftone. Our ultimate objective is to develop the shaded re-

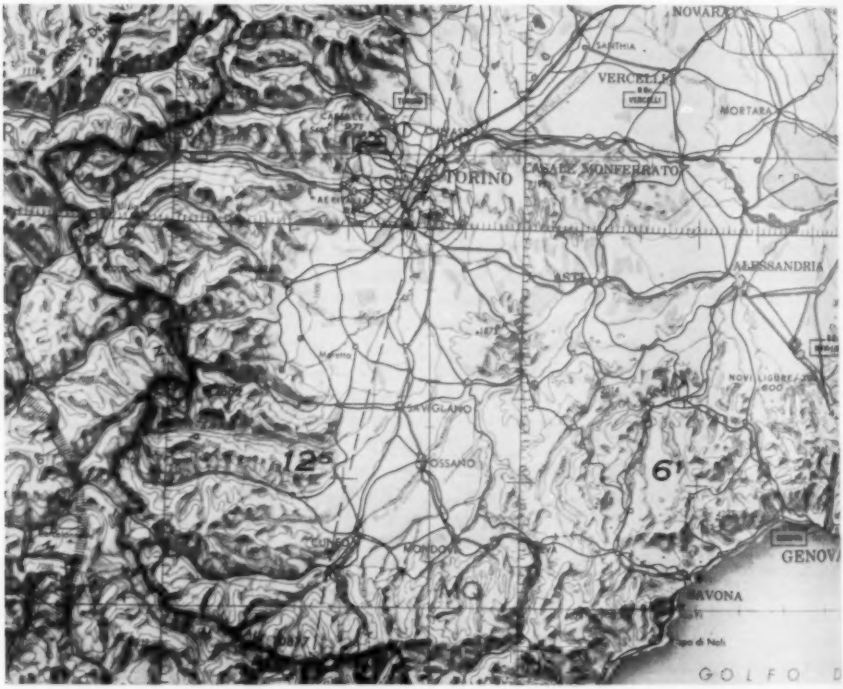

FIGURE 4.—Experimental Sample Chart No. 5, Family of Charts Experimental Program.

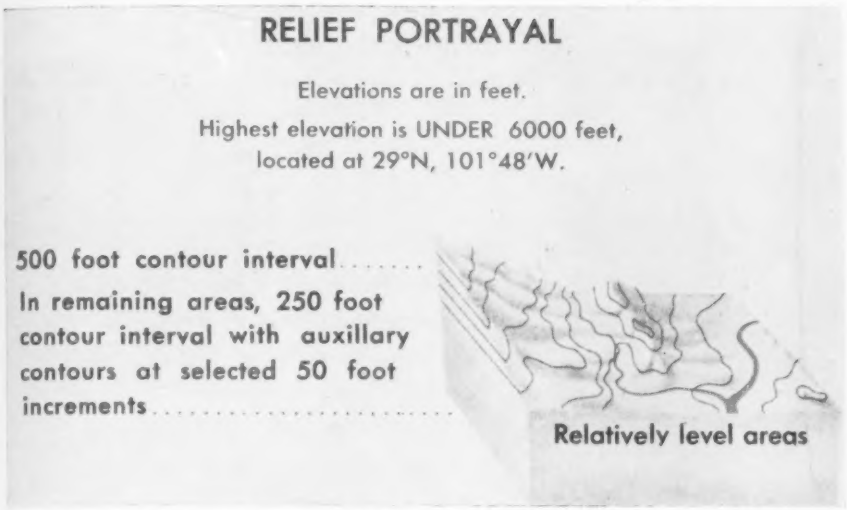

FIGURE 5.—Block diagram from WACX 469.

lief technique to a degree which will permit the elimination of this cap drawing.

The other elements of the relief picture are the tints used to indicate the general nature of the terrain. The conventional WAC had used gradient tints to indicate terrain-elevation levels delimited by contour lines. For this development we introduced a new concept which we identify as "relative" relief. In essence, we chose to indicate the flat and relatively level areas by a pale green tint. This tint was also extended into larger valleys in mountain areas to aid the relief portrayal. Figure 5 is a block diagram from WACX 469 which demonstrates this concept in the chart margin. Generally, relatively level areas are found in the lower elevations. However, when they occur at higher elevations, such as high plateaus, the green is somewhat lightened in tone. Areas of moderate or gently rolling relief are depicted in a pale yellow or buff tint which actually is underprinted throughout the land area of the chart. When the terrain changes from the relatively level to the moderate relief, the pale yellow breaks through and joins with shaded relief to portray the terrain forms. On many charts where the relief does not exceed what we define as moderate relief, only these two tints are used.

When rugged mountainous relief occurs, we chose to introduce a stronger yellow tint to draw attention to such areas for immediate perceptive association and to strengthen the relief picture. In addition, for purposes of identification of the highest mountain tops, we have added a brilliant yellow as a cap tint. No contour line is needed to separate the level area and moderate relief tints as the pale yellow tint merely breaks through the pale green level area tint. The two remaining yellow bands, however, used to represent mountainous areas and critical peaks in the highest land regions, are limited by selected contour lines. The entire concept of illustrating the terrain is to be based on regional studies to determine broad areas of different physiographic characteristics. Often this broad study will involve several World Aeronautical Charts.

This same concept has been carried over to our selection of contour intervals. Whereas the conventional WAC retained the same contour and gradient tint scheme the world over, our new chart permits the selection of varying intervals to best ex-

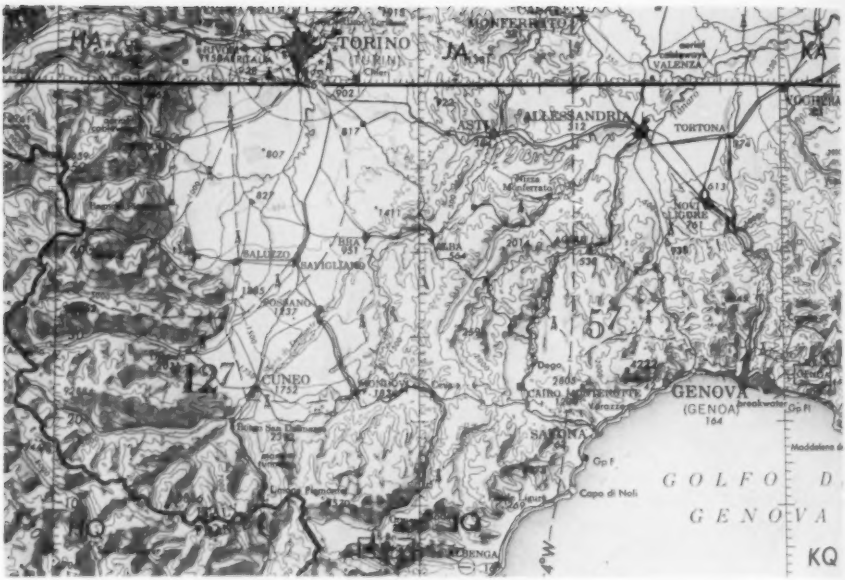

FIGURE 6.—Maximum elevation data.

press the terrain characteristics. Generally, a 250- or possibly 500-foot interval will be used in relatively level areas and areas of moderate slope. The more rugged mountain masses will normally be expressed in a 1,000-foot contour increment, although in some extremely steep areas, the interval may coincide with the system now used. Needless to say, it is very important to the chart user that we carefully indicate in the legend of the chart the intervals that are used. Normally this is done by stating the terrain elevations at which the contour interval is varied.

To make contours work even further, especially for the low level flight, we have introduced supplementary contours in various areas on the chart. Supplementary contours are shown only where the selected contour interval results in widely spaced contours. They serve to depict terrain formations that might not otherwise appear. Contours of selected 50-foot increments are used as supplementary contours in very flat areas where the standard interval is 250 feet. Our test chart of Texas (WACX 469) contains a supplementary contour at 100 feet and at 350 feet. By the same token, 250-foot-increment supplementary contours are used in areas where 500 to 1,000 is established as the basic interval. In order to retain a distinction between interval contours and supplementary contours, the interval contours are shown in brown with a line weight of 0.006 and supplementary in gray with a line weight of 0.004. Careful labeling of interval and supplementary contours is considered necessary.

We have retained spot elevations in more or less classical form in our new WAC design. The principal changes we have introduced are, first, a general reduction in type size, and second, the establishment of specifications which require the association of a spot elevation with a ground feature that we evaluate as identifiable from the air.

The treatment we have described so far for relief has been aimed at giving the user much more complete information than our normal WAC had accomplished. This completeness of information could not be accomplished without some sacrifice in pre-

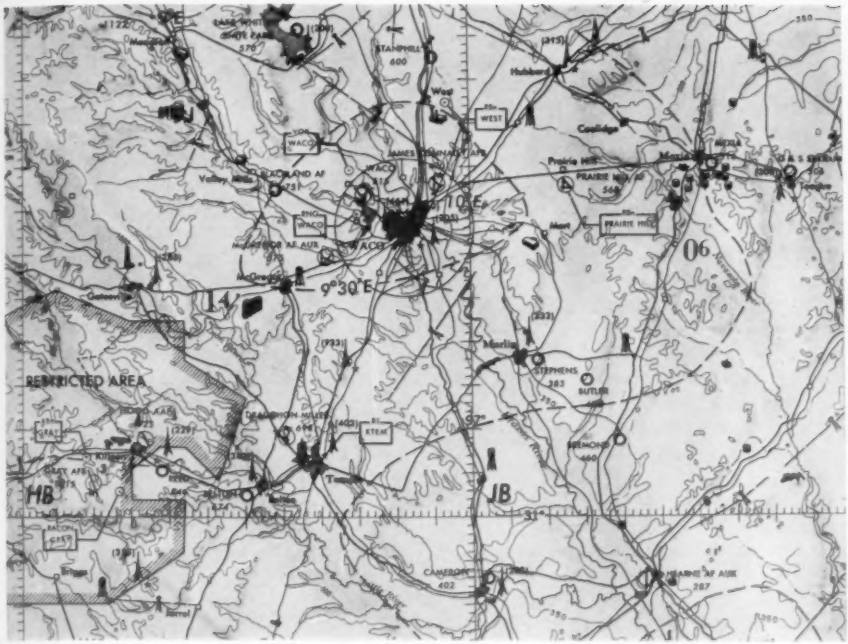

FIGURE 7.—Transportation Network at Waco, Texas, on WACX 469.

senting over-all terrain heights. Since the WAC has many navigational uses that do not require presentation of the terrain we chose a different but simple portrayal of terrain heights to serve for general overflying of the area. Under the heading of maximum elevation data we have portrayed (Fig. 6) the highest elevation within a 1° area on the chart by a large number appearing near the center of the 1° block. The highest elevation is expressed in thousands of feet by a large number followed by a smaller number rounded out to the next highest 100 feet. A minus sign following the figure indicates that although the highest ground elevation could actually be lower than the height expressed by the figure, it will not be higher. For example, in a 1° square labelled 6⁰–, you may find terrain heights up to six thousand feet; but insofar as can be determined, no elevation in excess of 6000 feet exists in the 1° block area. The type size and face shown for this "terrain clearance" is selected to provide legibility without chart clutter.

In summary, our general relief portrayal is extremely flexible and legible—it permits far more accurate interpretation of land forms in varied geographical areas, and it provides the user with an immediate appreciation of terrain changes. In addition, it has retained the features of absolute elevation required for flight planning and intelligence uses.

But relief is only a single feature on the WAC. I have devoted a major portion of this talk to relief because it represents perhaps our greatest departure from current design. Almost all of our cultural features have undergone some sort of change, not only in portrayal but in concept. The transportation network is a good example. (Fig. 7.)

The classification of roads has never quite escaped the influence of road maps and topographic sheets, those venerable fore-

runners of the aeronautical chart. Roads were put in one of several categories, dependent upon surfacing, weight-bearing capacity, width, and of course the importance of the connecting terminals. This type of classification is incompatible with the needs of an airman who first is interested in two things: Where is it on the chart? Can I see it from the air? The road itself does not ordinarily serve as a checkpoint; it is more often a line of bearing. When it can be associated with a more recognizable feature, or when its linear characteristic forms a unique pattern, then it may serve as a checkpoint. We have selected roads on this basis, therefore, and shown them by but two classifications. Dual lane highways are shown by a brown double line, and all other roads by a single brown line. When we implement a worldwide revision program for the WACs, we expect to add a third classification for trails, since in certain areas trails are a significant and distinguishable component of the transportation network.

Railroads are similarly simplified, except that only a single black line of varying thickness is used to signify either single or multiple track. You will notice that ticks, normally used to represent cross-ties, have been omitted to reduce chart clutter. All railroads are continued through towns as an aid to visual and/or radar identification.

Speaking of towns, I would like to describe our new portrayal of urban areas. Most charts are used under two types of lighting conditions, either natural daylight or white light, or under red light at night. Red light is more effective at night since it provides for greater visual adaptability when switching from the chart to outside the cockpit. Therefore, a violet (or magenta) city tint that will not fade under the red light filter is used—in fact, because it contains a certain amount of blue ink, it will actually darken. Cities represent very valuable landmark features. Thus we are portraying, insofar as possible, the actual built-up limits of each city. We call this the "visual" outline of urban areas. Surounding major urban centers are circles of approximately ten miles radius from their centers. Within these circles, we have shown a greater intensity of cultural features to aid in radar and visual identification.

Smaller towns and villages which, because of scale limitations cannot be portrayed by a visual outline, are shown by a small open square. Only the more important of these smaller towns are named. The elimination of many place names, which are not required during operational usage, has resulted in a cleaner, more legible chart. Also helpful towards achieving a more harmonious design has been the printing of city names in black, relief feature names in brown, hydrographic names in blue, and airdrome names in a screened reflex blue. In general, we feel we have improved the type style and at the same time made an over-all reduction in type size.

On several of the illustrations, you may see small three dimensional pictures dotting the landscape. These are nothing more than our man-made cultural features of either landmark or obstruction significance. Refer again to Figure 7. Visually significant roundhouses, industrial buildings, racetracks, TV towers, water tanks, bridges, etc., are all realistically drawn in miniature. But these are not merely artistic renderings. Actually they were developed as a means of aiding the chart user to quickly identify prominent cultural landmarks and obstacles. The new navigational technique of flying at great speeds and at critically low altitudes, has emphasized the need for providing safe terrain clearance data to the airman. Not only must the ground surface itself be clearly interpreted, but all protuberances which possess solid characteristics must also be made instantly obvious. Work is still progressing on the improvement of these pictorial symbols and will continue until we achieve optimum balance and design.

All obstructions and landmark features are located as closely as possible to their actual locations on the ground. Because of their horizontal exaggeration, however, a small star locates the exact position of obstacles, whereas a small black square locates other landmark features. The height of the obstructions above ground is given in parenthesis next to the symbol.

During World War II, many of our pilots

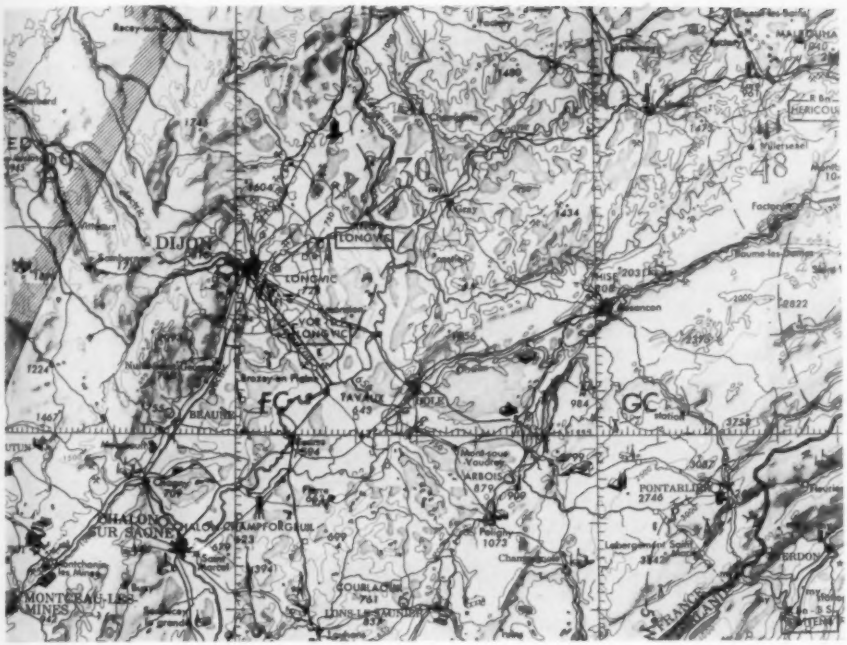

FIGURE 8.—Stable wooded areas in Europe.

discovered something about a particular landmark which the British and French had been aware of for quite some time. I am speaking of vegetation, more specifically, stable wooded areas. (Fig. 8.) Throughout most of Europe, trees are a carefully guarded commodity. Extensive forests are a rarity, but scattered groups of carefully protected trees form rather unique landmarks of distinct shape and density. Although these stable wooded areas were shown on our 1:250,000 AC, no attempt was made, until now, to portray them at the 1:1,000,000 scale. Our new vignetting technique, so successfully used to portray shorelines on the JN Series, has been applied to wooded areas on the new WAC. This permits integration of the green symbol with the pale green level area tint. Because the actual outlines of these wods would be difficult to see in mountainous areas, both on the chart and in real life, we have limited their portrayal to relatively level or light rolling terrain.

Our work on the redesign of aeronautical type information has been limited to those features which remain relatively stable. Although all known airfields are shown, only the runway patterns of major fields, exaggerated for legibility have been realistically portrayed. The circle you see around the runway pattern (note Prairie Hill AFB east of Waco on Fig. 7) has no meaning other than to represent a 6000 foot diameter centered on the runways. By comparing the extent of the runway with the 6000 foot circle, it is fairly easy to determine the approximate length of the runway. When the runway pattern is either unknown or classified for some reason, just a heavy circle symbol is used. Minor airfields which are of checkpoint value, or can be used for emergency landings, are portrayed by a smaller circle symbol.

All airspace reservations are portrayed alike and labelled for identification. Major radio facilities are located by a dot and small circle leading to a reduced size box which contains the type and name of the facility.

Isogonic data is portrayed in greater detail than on previous charts. Not only has the variation interval been increased to 30 minutes, but a truer alignment of the lines of variation has been shown. Also, where information is available, local anomalies are portrayed to indicate severe deviations from the normal. The isogonic portrayal is currently under study to determine whether the 30 minute values are actually required.

This just about covers the features on the chart face, with the exception perhaps of drainage. I have already mentioned the vignette technique which was used for the vegetation portrayal. We have applied vignette to the water portrayal for most of our standard series charts because it renders great portions of certain charts free of color for more effective plotting and marking. The vignette technique may be considered a mechanical process resulting in an artistic rendition—an instance where light migration has served a real purpose.

You may have noticed the new WAC legend in Figure 2. We have tried to give it eye-appeal so that operational people will take the time to study the new legend and become familiar with our "New Look" design. In time, the legend will be modified and reduced as user experience and familiarity increases.

The remaining marginal information reflects further redesign, simplification, and increased utility. Our bar scales, in nautical, statute, and kilometer measurements, are portrayed in ruler style for convenient use. They run the complete length of the chart's neatlines to permit comprehensive east-west measurement.

All vital information concerning the chart's name, area, and significant compilation dates, is grouped in the extreme east fold. This will facilitate reference and filing.

All of these marginal features are found only in the south and west borders of the new WAC. We have eliminated the north and east margins and extended chart detail to the edge of the sheet strictly for user convenience, because many flights normally extend beyond the borders of a single chart. Also, much tactical and flight planning involves areas of four or more WACs. Our partial margin format has thus eliminated the user's need to trim his chart for joining.

CONCLUSION

You have seen black and white reproductions of our newest World Aeronautical Chart. You have read our explanation of the new design characteristics and the system that created them. But this is really only part of the full story. I mention this because, if we distributed millions of copies of our new WACs to Air Force personnel throughout the world and did nothing more, our job would only be half done. We *believe* we have created a good chart—a better WAC than ever before. But we must *know* that these new ideas, concepts and portrayals will benefit the man in the field, the chart user. We have therefore prepared comprehensive questionnaires to test the reaction of the user to our new design. Completed questionnaires will be carefully tabulated and analyzed for major trends and opinions. At this moment our new WACX 469 of Texas is undergoing extensive field testing by operational units of all major Air Force Commands in the Zone of Interior. This includes use of the chart during actual missions and also simulated desk study. Two other prototypes in the European area, WACX 253 and WACX 231, are almost ready for similar testing by units of U. S. Air Force in Europe. The final testing ground will be Korea, where the Far East Air Forces are scheduled to test WACX 380.

Thousands of questionnaires will be pouring in from all over the world. Facing us is the huge task of tabulating, analyzing, and evaluating the results of this worldwide survey; but when it is over, we will have documented evidence of the users' rejection or acceptance of our new design. At this time we are happy to report that the initial reaction from operational personnel is favorable. If this trend continues, our new WAC design will soon become familiar to users of World Aeronautical Charts throughout the world.

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Coast and Geodetic Survey Field Demonstration of Surveying and Mapping Operations

By ERNEST J. PARKIN

COAST AND GEODETIC SURVEY

THE COAST and Geodetic Survey acted as host organization for the 1957 Annual Meeting of the Society of American Military Engineers held at Washington, D. C., last May. Personnel of the Coast and Geodetic Survey arranged a field demonstration and exhibit of their surveying and mapping activities, emphasizing the fact that during 1957 the Survey is celebrating its Sesquicentennial Anniversary.

The site of the exhibit and field demonstration was the park area between the Ellipse and Fifteenth Street and to the west of the Survey's offices in the Commerce Building.

Officials of the National Capital Parks of the National Park Service granted permission for the use of the area, and also extended their cooperation by furnishing help in the staging of the exhibit as well as chairs for a "bleacher section" for the convenience and comfort of persons watching the erection of a ninety-foot steel tower.

The erection of this tower was the main feature of the exhibit. (Fig. 1.) An experienced crew of five men, from a field party working in the vicinity of Washington, demonstrated the rapid erection of one of the ninety-foot standard double steel towers used regularly in the extension of the national triangulation net. After lunch, the same tower crew demonstrated the process of dismantling the tower.

The tower was erected in the center of a large circle which was roped off for the protection of the spectators. The seats in the "bleacher section" on the south side of the circle enabled those who watched the demonstration to do so in comfort, barring, perhaps, a "crick in the neck" here and there.

Four large army tents were erected to house the exhibits of the work of the technical divisions of the Survey. The first tent, located southeast of the tower circle, was devoted to the work of the Chart Division, which includes both nautical and aeronautical charts. Panels featuring the highlights of chart compilation and construction were on display. However, the feature of this exhibit which attracted the most attention was a series of tables at which employees were at work on the various operations of chart making, such as base compilation, drafting, and yellow-coat scribing.

Proceeding from the Charts tent, clockwise around the tower circle, the guests came to the tent located southwest of the circle. This housed the displays of two divisions, Coastal Surveys and Tides and Currents.

The principal items displayed by Coastal Surveys were EPI equipment, used for positioning offshore soundings; a fathometer; and a survey sheet showing Shoran control of the hydrography. The Tides and Currents Division exhibited a number of ocean-

FIGURE 1.—Partly completed steel tower.

ographic instruments. These included a sea water thermograph; a U-tube from the instrument designed for seismic sea wave detection; air and sea water thermometers; hydrometers; current meters, both the Price meter and the standard C&GS type developed by the Survey; and standard and portable tide gages.

The mobile press van of the 955th Engineer Company (Topographic) was located west of the tower. Visitors to this exhibit were given an interesting sheet containing an account of military mapping activities of the Coast and Geodetic Survey during the period of the Civil War and reproductions of a plate of battlefield plans and a chart of the coast of South Carolina and Georgia. The 955th Engineer Company is an Army Reserve unit sponsored by the Coast and Geodetic Survey.

A third tent, northwest of the tower circle, contained exhibits of the Division of Photogrammetry and the Division of Geophysics. Included among the instruments in the Geophysics display were a visible recording magnetograph, a transit magnetometer, and various types of field instruments, including a magnetometer and galvanometer. The Division of Photogrammetry exhibited various types of surveying instruments for field use and a number of photographs. These included large photographs of New York and Washington, as well as numerous illustrations of the field work of the Division. Office equipment in this display included a Kelsh plotter, a Logetronic contact printer, and a Zeiss automatic developing tank.

Another feature of Photogrammetry's display was a mobile photogrammetric office used for photo-hydro support. Trailer equipment included a desk projector and a swinging-gate stereoscope. Cabinets housed equipment needed by the party, such as office supplies, outboard motors, life preservers, and field equipment.

The fourth tent, located northeast of the tower circle, was devoted to the work of the Division of Geodesy. About two-thirds of the tent was partitioned off by panels on which were shown photographs of various phases of the work of the Division. In the "theater" section there was a continuous showing of the Coast and Geodetic Survey film "Surveyors at Work" alternating with "Men, Steel, and Earthquakes" issued by the Bethlehem Steel Company. In the "lobby" end of the tent there was a table on which were a Brown pendulum gravity instrument and a Worden gravimeter. An old-instrument display included a 12-inch theodolite, used from 1900 to 1925; a zenith telescope of 1849; and a carbide signal lamp such as was used from 1910 to 1920. Another table held samples of the manuals covering various phases of geodetic surveying and descriptions of the available data of interest to surveyors and engineers.

In addition to the display in the tent, Geodesy had a number of outdoor exhibits. There was a tower cage (Fig. 2.) on the ground at the north side of the tower circle. This enabled guests to see how the top of the tower was built, without the labor of

FIGURE 2.—The tower cage set up on the ground. This assembly is normally at the top of the tower.

climbing the tower. Alongside the cage was a vertical collimator, used to locate the instrument on the tower directly over the ground mark. Just inside the Fifteenth Street sidewallk a field crew demonstrated the method of measuring a base line.

A "midway" extended about 250 feet north from the tower circle. (Fig. 3.) On either side of this the visitors saw instruments used in astronomy, triangulation, and geodetic leveling.

FIGURE 3.—The "midway" from the top of the completed tower.

In this display were included a Bamberg transit instrument and a Wild T4; a Geodimeter and a Tellurometer, new electronic distance measuring instruments; and precise levels, both the standard C&GS type and the Wild N3, complete with umbrellas and invar rods. At this display a spectator could actually make his own observations, and many of them took advantage of the opportunity. Near the levels was a large tripod used to support a gasoline-powered hammer (Fig. 4.) for driving copper-coated steel rods which have been used in a number of locations as bench marks. Finally, on the west side of the "midway" was a ground station, with an observing tent and a Wild T3 theodolite which "saw" three stations marked by three different kinds of signal lamps. (Fig. 5.)

FIGURE 4.—Gasoline-powered hammer for driving rods used as bench marks in some localities.

About 400 members and guests of the Society of American Military Engineers in attendance at the annual meeting were visitors at the exhibits and demonstrations. In addition several local schools accepted invitations to view the displays, and entire classes in surveying and engineering courses took advantage of this unusual opportunity to see equipment and demonstrations not usually available to them.

FIGURE 5.—A visitor "takes a look" through the telescope of a T3 theodolite at the ground station.

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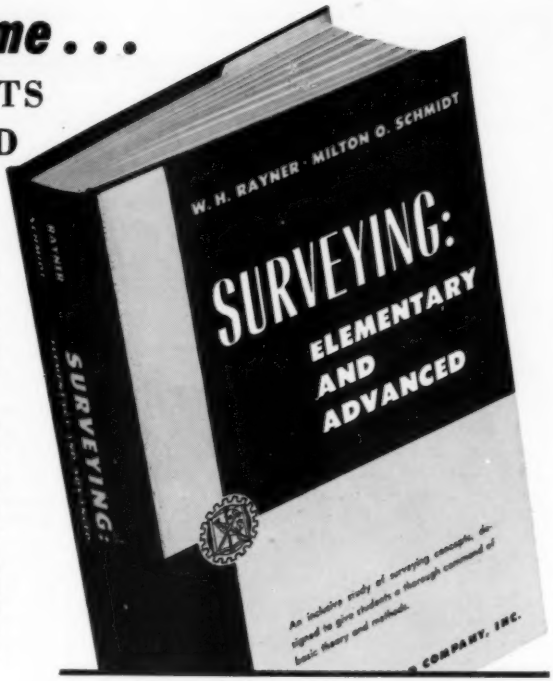

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MAGAZINE ARTICLES

General Interest

THE NEW GOLDEN AGE OF HYDROGRAPHY. Commander L. Oudet, French Navy Hydrographic Office. *The International Hydrographic Review,* Vol. 33, No. 2, November 1956. (Review of progress in production of charts, sailing directions, and nautical information.)

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GENERAL GEOGRAPHY. O. D. Von Engln and Bruce Carlton Netschert. (Clare M. O'Gorman, cartographer.) New York, Harper and Brothers, 1957. 681 pp., maps. Harper's Geoscience Series.)

PRACTICAL APPLICATIONS OF ENGINEERING SOIL MAPS. William W. Holman, Robert K. McCormack, James P. Minard, and Alfreds R. Jumikis. Rutgers University Press, Engineering Research Bulletin No. 36. 114 pp., illus. $3.00.

—LYMAN D. LYNN

Coast and Geodetic Survey

DISTINCTIVE RECENT MAPS

World of Tobacco is a May 1957 publication of the Foreign Agricultural Service, U.S. Department of Agriculture. By dots of different color the map shows world distribution of flue-cured, light air-cured, Oriental and Semi-Oriental, and "all other" types of tobacco. Pie graphs show production and consumption for various countries. The scale is approximately 1:20,000,000 and the size is 27 by 48 inches.

A map showing *The National System of Interstate and Defense Highways of the United States* was published in 1957 by Portland Cement Association, 33 West Grand Avenue, Chicago 10, Illinois. "This is a map of the most important highway system in the United States. It totals 41,000 miles of arterial streets and heavy-duty roads, only a little more than one per cent of this country's 3,360,000 miles of roads. But when completed, this system will carry more than twenty per cent of all traffic." The map, which was prepared by the General Drafting Company, is at the scale of 1:5,700,000 and measures 24 by 33½ inches.

A new reprinting of the map showing *Generalized Types of Farming in the United States* was issued in April 1957 by the Agricultural Research Service, U.S. Department of Agriculture. Nine major farm types, as well as non-farming areas, are shown on the map. The scale is 1:10,000,000 and the sheet size 16 by 22 inches. It is printed in the format of the looseleaf "National Atlas of the United States."

The *State of Pennsylvania* is a recent addition to U.S. Geological Survey's series of shaded relief maps of the several States. It is at the scale of 1:500,000 and measures 26 by 41 inches. It is based on the Survey's topographical quadrangles and the Army Map Service's strategic map at the scale of 1:250,000. County outlines, rivers and streams, and a number of towns and cities are shown. The skillful shading technique strikingly brings out the varied and interesting landforms of the Keystone State.

Agricultural Regions of Canada are delimited on a black and white map published in 1956 by the Geographical Branch, Department of Mines and Technical Surveys, Toronto. On a sheet 28 by 39 inches the eastern and western agricultural regions of the Commonwealth are outlined on separate maps. The scale is approximately 1:2,000,000. Ten regions, subdivided under "Livestock Specialty," "Special Crops," "Grain Specialty," and "Combination Grain and Livestock" are shown.

Paul-Emile Victor, noted French polar explorer, has compiled a series of maps on the *Ice-Geography of Greenland*, which was published in 1955–1956 by Blondel la Rougery of Paris. The maps measure 23 by 20½ inches and are at the scale of 1:5,000,000. Titles and legends are in French and English. Data shown on the separate maps are (1) limit of the maritime and continental climates, (2) probable extent of danger zone (crevasses), (3) probable limit of the icecap, and (4) probable extent of summer thaw.

A *Physical Map of Great Britain*, in two sheets, is a 1957 publication of the Ordnance Survey, Chessington, Surrey. Each sheet measures 32 by 40 inches and the scale is 1:625,000. Color gradients, ranging from light green to tan to varying shades of brown, indicate relief, and blue tints show submarine topography.

Another Ordnance Survey publication (1955), at the same scale and size, shows distribution of *Limestone Including Chalk* in Great Britain. It was compiled by the Ministry of Housing and Local Government, and includes data supplied by the Geological Survey and the Ministries of Fuel and Power, Transport, Supply and Works. Distribution of eleven different limestone formations, ranging from Ordovician to Recent, is shown.

La Limite Eumediterranéenne et les Contrees de Transition maps the limits of olive culture and transition zones of the regions bordering the Mediterranean Sea. It was compiled by H. Gaussen and A. de Philippis and published by the Food and Agriculture Organization (F.A.O.) of the United Nations. Reproduction is by Les Procédés Dorel, Paris. The map measures 23 by 44 inches and has a scale of 1:5,000,000.

A *Land Utilization Map of Cyprus* has been compiled under the direction of R. R. Rawson and K. R. Sealy, Department of Geography, London School of Economics, University of London, with the assistance of several other colleagues and students. The map, which is at the scale of 1:250,000, was prepared from information derived from about 10,000 air photographs. The land classification used is that proposed by the Old World Division of the World Land Use Survey, and includes nine categories of use for Cyprus. The map was published in 1956, by Geographical Publications, Ltd. (London), for the World Land Use Survey (L. Dudley Stamp, Director). It is 20½ by 32½ inches.

World attention lately has been focussing upon the continent of Africa and its various political divisions and subdivisions. This interest is reflected in a number of new maps. In 1956 the Directorate of Colonial Surveys (Great Britain) published a three-sheet map of *Gambia* at the scale of 1:125,000. It is available from Edward Stanford, Ltd. 12/14 Long Acre, London, W.C. 2, England. The map, which is limited to the immediate drainage basin of the Gambia River, shows three classes of roads, footpaths, interna-

tional and internal administrative boundaries, wharf towns, forest parks, vehicle stations, and divisional headquarters. Sheet one measures 32 by 24 inches, and sheets two and three are 32 by 44 inches.

Cartes des Sols d'Algérie, Plaines du Chélif, is a large scale (1:50,000) detailed soil map of the Chelif region between the cities of Alger and Oran. Distribution of some forty different soil types is shown by colors and symbols. The sheets, which are adjoining, from east to west show (1) Plaine d'Affreville, (2) Plaine de Carnot, (3) Plaine d'Orléansville, (4) Plaine d'Inkermann, and (5) Plaine de Relizane.

Algérie Nord shows the territorial reorganization of Algeria as delimited by the decree of June 28, 1956. It was published by Service Cartographique, Gouvernement Général de l'Algérie. The size is 12½ by 26½ inches and the scale 1:1,500,000.

Two economic maps of French Equatorial Africa (*Afrique Equatoriale Française, Carte Economique*) were published in 1956 by France's Institut Géographique National. Map No. 1 shows several classes of towns, roads, and waterways, as well as agricultural, forest, and industrial zones. Map No. 2 locates major mineral and industrial centers. Both maps are at the scale of 1:5,000,000 and measure 28 by 18 inches.

A general map of *Kenya* at the scale of 1:3,000,000, is a 1955 publication of the Survey of Kenya (Nairobi). Internal and external boundaries, roads, railroads, administrative headquarters, wells, waterholes, and spot elevations are shown. The map measures approximately 15 by 14 inches.

The Federal Survey Department, Lagos, Nigeria, published in 1956 a *Road Map of Nigeria* at the scale of 1:1,750,000. Railways, communication lines, air fields, administrative and international boundaries, form lines, and spot elevations are shown in addition to several classes of roads. The map is 26 by 31½ inches in size.

A Geological Map of Nigeria 1954 was compiled by the Nigerian Geological Survey, R. R. E. Jacobson, Director. It was published, at the scale of 1:2,000,000, by the Director of Federal Surveys, Lagos, Nigeria, in 1956. Eighteen geological formations, ranging from Pre-Cambrian to Pleistocene, are mapped. Measurements of the map are 22 by 35 inches.

Carta de Angola is a 1956 publication of Junta das Missões Geograficas e de Investigacoes do Ultramar, Ministerio do Ultramar (Lisbon, Portugal). This general map, of the Portuguese colony in southwest Africa, shows major water courses, roads, railroads, airports, towns and cities, and Protestant and Catholic missions. The scale is 1:2,000,000 and the dimensions are 37 by 30 inches.

Mapa das Estradas de Moçambique is a road map of the Portuguese colony of Mozambique on the southeast coast of Africa. Five classes of roads, with distances in kilometers between places are shown on this map which is at the scale of 1:3,000,000. A number of tourist attractions are also indicated. On the verso there is a list of roads in Mozambique with "mileage" for each (in kilometers). Also on the verso is advertising of Manufactura Nacional de Borracha (an affiliate of the General Tire and Rubber Co.) publishers of the map. Measurements of the sheet are 28 by 17 inches.

States and Districts of India and Pakistan, as of 1956, are delimited on a map published by Bureau of Commercial Intelligence and Statistics, Central Bank Building, Bombay 1, India. States, with districts, are listed in the map margins. The map measures 29 by 39 inches and the scale is 1:4,000,000.

The Settlement of Penang Land Utilization Map maps details of land use of a portion of western Malaya. It includes the island of Penang in the Straits of Malacca. The map, which is at the scale of an inch to a mile, was published in 1954 under the direction of the Surveyor General, Malaya. Principal categories of use are rubber, padi, other agricultural, forest, and land set aside for government or public purposes. Transportation and communication lines, populated places, rivers, canals, and administrative boundaries are also indicated. The map measures 39½ by 29½ inches.

—WALTER W. RISTOW
Library of Congress

Joint Fall Meeting

The Cartography and Topography Divisions of the American Congress on Surveying and Mapping have joined forces this year to present a fall program which is designed to be timely and interesting to all in the surveying and mapping field.

The main topic of the meeting will be: "How to Make a Living Making Maps."

Representatives of government and private industry are expected to relate how regulations, training, professional status, and job opportunities are affecting career opportunities in the field of mapping.

The meeting is scheduled to be held in the Interior Department Auditorium, November 6, 1957, at 8:30 p.m.

Books in Review

ATLAS OF TREASURE MAPS. Ferris LaVerne Coffman. *Thomas Nelson and Sons*, New York, 1957. $10.00.

Ferris LaVerne Coffman, treasure hunter and president of the Algomah Instrument Company of Mackinaw City, Mich., has compiled an *Atlas of Treasure Maps*. The first work of its kind, this attractive atlas contains 41 maps which indicate the general location of some 3,000 authenticated treasures, largely in the Western Hemisphere. Most of the maps are reduced copies of Coast and Geodetic Survey charts in four colors; a few were drawn for the atlas. The lists accompanying the maps record modern wartime ship losses as well as wrecks of pirate vessels and Spanish treasure fleets. Mr. Coffman has spent nearly 20 years in research and occasional treasure hunting.

In the Preface the author notes that "The spirit of adventure lives and thrives in the soul of the treasure-seeker. In his avocation he finds an escape from the ordinary character of life and he will soon discover that he is making daily plans. There is an old saying: 'You will never grow old if you arise each morning with a plan for the day'. First you need a map. Here are maps for you . . . and here's wishing you good luck in your treasure hunts."

J. Douglas Hill

Library of Congress

Ten-place Trigonometric Tables in Grads

The German Geodetic Commission recently published a 10-place table of sines, cosines, tangents, and cotangents to each one-hundredth of a grad. The general format and type style of the tables are excellent. However, there are no tabular differences.

The tables may be obtained from Dr. M. Kneissl, German Geodetic Commission, Munich, Germany.

Intracoastal Waterway Series

The Intracoastal Waterway, extending from Boston, Mass., to Brownsville, Texas, affords a route for small craft navigation which passes almost entirely through protected waters and land-cut channels. Construction of the Atlantic Section was begun in 1911, and the route between Norfolk and Key West was completed in 1936.

At this time the Coast and Geodetic Survey published the first charts of its Intracoastal Waterway "800" Series. During subsequent years, publication of additional charts of the series has kept pace with the waterway construction. Completion of the Gulf Intracoastal Waterway, a route with minimum width of 125 feet and controlling depth of 12 feet, in 1949 was followed closely by publication of the latest of these charts, bringing the total number in the series to 61.

The charts of the Intracoastal Waterway are published at a scale of 1: 40,000 and are designed to meet the chart needs of the small craft navigator. All charts of the Atlantic section are of one size, as are those of the Gulf section. They are printed in pairs, on both sides of the paper, and cost 50 cents. Thus, storage is facilitated and the charts may be bound if desired.

The principal source material for this series consists of basic hydrographic and topographic surveys of the Coast and Geodetic Survey, supplemented by channel surveys of the Corps of Engineers. Periodic field inspections of the entire Waterway and airphoto study of changing areas serve to supplement these surveys and enable the Coast and Geodetic Survey to depict the latest natural changes and cultural improvements on the published charts.

The clarity of the charts has been improved by the use of colors. These include the red line which marks the recommended route, the red junction line at the end of each chart panel, the blue tint of water areas with depths of six feet or less at mean low water, and the green tint to symbolize marsh areas.

These charts may be obtained by addressing the Coast and Geodetic Survey, Washington 25, D. C., or any of its District Offices. They are also for sale by numerous agents in cities and towns along the Waterway.

MAP INFORMATION

This department was inaugurated for the purpose of bringing to the attention of the members information pertaining to the availability of maps, surveys, etc., with particular emphasis on how such material can be procured. It is believed that through an interchange and dissemination of such information maximum benefits will accrue to the surveying and mapping profession.

—EDITOR

Topographic Maps

THE FOLLOWING quadrangle maps were published by the U. S. Geological Survey between March 1 and May 31, 1957. The list includes newly compiled maps; revised maps on which contours and drainage usually are unchanged but the works of man are brought up to date; and series-converted maps which are 15-minute maps produced from four 7½-minute maps of the same area. The maps are new unless otherwise designated by numerical superscript.

The quadrangle name (in capital letters) is followed by the name of the county (in upper- and lower-case letters) that contains the place or feature for which the quadrangle is named.

All maps are available with or without the green overprint that indicates woodland. These maps show the shape and elevation of the land surface (represented by contour lines, printed in brown); water features (in blue); works of man, including cities, towns, and scattered habitations, schools, churches, railroads, roads and boundaries, place and feature names (in black); and woodland areas (in green). Principal roads are shown by a red overprint. In areas that have been covered by Bureau of Land Management surveys, township and section lines are shown. The State rectangular coordinate systems are indicated in the margins of the maps. An information folder further describing topographic maps is available on request.

Standard quadrangle maps may be obtained for 30 cents per copy. A discount of 20 percent is allowed on orders amounting to $10 or more at the retail price; a discount of 40 percent is allowed on orders amounting to $60 or more. Orders should be addressed to the U. S. Geological Survey, Washington 25, D. C., (or Denver 15, Colo., for maps of areas west of the Mississippi River).

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* Indicates 15-minute quadrangle; all others are 7½-minute quadrangles.
[1] Indicates a revised map.
[2] Indicates a series-converted map.
† Indicates availability in either a contour or a shaded relief edition.
‡ Indicates preliminary black and white edition.

Alabama

BELLEFONTAINE—Mobile
CENTER HILL—Lauderdale
WHEELER DAM—Lawrence

Alaska

CRAIG (A-1)*—First Judicial Division
CRAIG (A-4)*—First Judicial Division
CRAIG (A-5)*—First Judicial Division
CRAIG (B-6)*—First Judicial Division
DIXON ENTRANCE (C-1)*—First Judicial Division
DIXON ENTRANCE (C-3)*—First Judicial Division
DIXON ENTRANCE (D-1)*—First Judicial Division
DIXON ENTRANCE (D-4)*—First Judicial Division
DIXON ENTRANCE (D-5)*—First Judicial Division
HAGEMEISTER ISLAND (D-3)*—Third Judicial Division
HAGEMEISTER ISLAND (D-6)*—Fourth Judicial Division
HEALY (B-5)*—Fourth Judicial Division
HEALY (C-5)*—Fourth Judicial Division
KANTISHNA RIVER (A-5)*—Fourth Judicial Division
KANTISHNA RIVER (B-6)*—Fourth Judicial Division
MT. FAIRWEATHER (A-2)*—First Judicial Division
MT. FAIRWEATHER (B-1)*—First Judicial Division
MT. FAIRWEATHER (B-2)*—First Judicial Division
PRINCE RUPERT (D-6)*—First Judicial Division
SITKA (B-2)*—First Judicial Division
SITKA (C-6)*—First Judicial Division
SUMDUM (B-5)*—First Judicial Division
SUMDUM (C-5)*—First Judicial Division
SUMDUM (D-5)*—First Judicial Division
TELLER (A-3)*—Second Judicial Division

TELLER (A-4)*—Second Judicial Division
TELLER (B-1)*—Second Judicial Division
TELLER (B-2)*—Second Judicial Division
TELLER (B-3)*—Second Judicial Division
TELLER (B-4)*—Second Judicial Division
TELLER (B-5)*—Second Judicial Division
TELLER (B-6)*—Second Judicial Division
TELLER (C-4)*—Second Judicial Division

Arizona

‡BLACK FALLS NE—Coconino
‡BLACK FALLS 4 SE—Coconino
‡CAMERON SE—Coconino
‡COCONINO PT. NE—Coconino
‡COCONINO PT. SE—Coconino
‡GRAND FALLS NE—Coconino
‡LITTLEFIELD 3 NE—Mohave
‡LITTLEFIELD 3 SE—Mohave
‡LITTLEFIELD 3 SW—Mohave
‡MAL PAIS SPRINGS 3 SW—Navajo
‡ST. JOSEPH 1 NE—Navajo
‡ST. JOSEPH 1 NW—Navajo
‡ST. JOSEPH 1 SE—Navajo
‡ST. JOSEPH 2 NE—Navajo
‡ST. JOSEPH 2 NW—Navajo
‡ST. JOSEPH 2 SE—Navajo
‡SUNSET KNOLL 2 NW—Coconino
‡SUNSET KNOLL 2 SE—Coconino
‡SUNSET KNOLL 2 SW—Coconino
‡THE GAP SW—Mohave
‡WINSLOW 1 SW—Navajo
‡WINSLOW 2 NW—Navajo
‡WINSLOW 2 SE—Navajo
‡WINSLOW 2 SW—Navajo
‡WINSLOW 4 NE—Navajo
‡WINSLOW 4 NW—Navajo
‡WINSLOW 4 SE—Navajo
‡WINSLOW 4 SW—Navajo
‡WOLFORD SPRINGS 3 NW—Apache
‡WOLFORD SPRINGS 3 SW Apache
‡ZITH-TUSAYAN BUTTE 3 NE —Apache
‡ZITH-TUSAYAN BUTTE 3 NW —Apache
‡ZITH-TUSAYAN BUTTE 4 NW —Apache

Arizona-New Mexico

‡ZITH-TUSAYAN BUTTE 4 NE —Apache

Arkansas

ALEXANDER[1]—Pulaski
BRYANT[1]—Saline
CABOT[1]—Lonoke
CATO—Faulkner
JACKSONVILLE[1]—Pulaski
KEO[1]—Lonoke
LITTLE ROCK[1]—Pulaski
MARVELL*—Phillips
MAYFLOWER—Faulkner
McALMONT[1]—Pulaski
NEWARK—Independence
NORTH LITTLE ROCK[1]—Pulaski
OLMSTEAD[1]—Pulaski
PINNACLE MTN.[1]—Pulaski
PRINCEDALE—Cross
SCOTT[1]—Lonoke
SPRING LAKE[1]—Saline
SWEET HOME*[1]—Pulaski
WHITMORE*[1]—St. Francis
WOODSON[1]—Pulaski

California

ADELAIDA*[2]—San Luis Obispo
ADOBE MTN.—Los Angeles
ALPINE—San Diego
AVENAL[1]—Kings
BAKER*—San Bernardino
BALDY MESA—San Bernardino
CABAZON—Riverside
CEDAR SPRINGS—San Bernardino
DAVENPORT—Santa Cruz
DOMENGINE RANCH[1]—Fresno
DURMID SE—Imperial
EAST ELK HILLS[1]—Kern
EL CAJON MTN.—San Diego
ELKHORN HILLS[1]—San Luis Obispo
EL RICO RANCH[1]—Kings
EMERALD BAY—El Dorado
FELTON—Santa Cruz
FRANKLIN POINT—San Mateo
FRINK—Imperial
GILROY HOT SPRINGS—Santa Clara
GUERNSEY[1]—Kings
HAMMOND RANCH—Fresno
HANFORD[1]—Kings
HESPERIA—San Bernardino
IRIS WASH—Imperial
KETTENPOM—Trinity
KETTLEMAN CITY[1]—Kings
LA CIMA[1]—Kings
LAGUNA SECA RANCH—Merced
LAKE FULMOR—Riverside
LICK OBSERVATORY—Santa Clara
LOKERN[1]—Kern
MISSISSIPPI CREEK—Santa Clara
MONOCLINE RIDGE—Fresno
MORONGO VALLEY*—San Bernardino
MT. BOARDMAN—San Joaquin
MT. DAY—Santa Clara
MT. STAKES—Santa Clara
OBSIDIAN BUTTE—Imperial
OLD DAD MTN.*—San Bernardino
OTAY MESA—San Diego
PACHECO PEAK—Santa Clara
PANORAMA HILLS[1]—San Luis Obispo
PENTLAND[1]—Kern
PFEIFFER POINT—Monterey
PHELAN—San Bernardino
RAMONA—San Diego
SAN GORGONIO MTN.*—San Bernardino
SAN PASQUAL—San Diego
SILURIAN HILLS*—San Bernardino
STRATFORD[1]—Kings
STRATFORD SE[1]—Kings
TUMEY HILLS—Fresno
VICTORVILLE NW—San Bernardino
WAUKENA[1]—Tulare
WELLS RANCH[1]—San Luis Obispo
WEST ELK HILLS[1]—Kern
YOLLA BOLLY*—Tehama

California-Nevada

BOCA—Nevada
LOYALTON*—Sierra
MARTIS PEAK—Placer

Colorado

COALMONT—Jackson
COWDREY—Jackson
DELANEY BUTTE—Jackson
EAGLE HILL—Jackson
GOULD—Jackson
GOULD NW—Jackson
GRAND MESA—Mesa
LAZEAR—Delta
MACFARLANE RESERVOIR—Jackson
MOLINA—Mesa
OURAY—Ouray
OWL RIDGE—Jackson
PEORIA—Arapahoe
PITCHPINE MTN.—Jackson
SHIPMAN MOUNTAIN—Jackson
SILVERTON—San Juan
TEAL LAKE—Jackson
TELLURIDE—San Miguel
WALDEN—Jackson

Connecticut

WATERBURY[1]—New Haven

Delaware

BENNETTS PIER[1]—Kent
LAUREL—Sussex
SEAFORD EAST—Sussex

Delaware-Maryland

SEAFORD WEST—Sussex
SHARPTOWN—Wicomico

Florida

ALLANTON[1]—Bay
BEACON BEACH[1]—Bay
BEACON HILL[1]—Gulf
BRANDON—Hillsborough
CROOKED ISLAND[1]—Bay
DUETTE—Manatee
DUETTE NE—Manatee
EDGEVILLE—Manatee
FT. LONESOME—Hillsborough
GARDNER—Hardee
GIBSONTON—Hillsborough
GRIFFINS CORNER—Hardee
KEENTOWN—Manatee
LONG POINT[1]—Bay
MYAKKA HEAD—Manatee
NORTH OF ALLANTON[1]—Bay
ONA—Hardee
PANAMA CITY[1]—Bay
PANAMA CITY BEACH[1]—Bay
RIVERVIEW—Hillsborough
RUSKIN—Hillsborough
SAFETY HARBOR—Pinellas
SULPHUR SPRINGS—Hillsborough
WIMAUMA—Hillsborough
ZOLFO SPRINGS—Hardee

Florida-Georgia

DOGTOWN—Gadsden
EDDY—Baker
JENNINGS—Hamilton
MT. PLEASANT—Gadsden
SARGENT—Baker

Georgia

BIRMINGHAM—Fulton
MARIETTA—Cobb

Georgia-Florida

CLYATTVILLE—Lowndes
GROOVERVILLE—Brooks
MONTICELLO NE—Jefferson
NANKIN—Brooks

Hawaii

KAHAKULOA—Maui

Idaho

FIRTH—Bingham
PINGREE—Bingham

Indiana

ALPINE—Fayette
CLEAR CREEK—Monroe
CONNERSVILLE—Fayette
COPE—Morgan
CORUNNA—De Kalb
EVERTON—Fayette
KENDALLVILLE—Noble
LOGANSPORT—Cass
MONTEZUMA—Parke
MOORESVILLE WEST—Morgan
NEW MARKET—Montgomery
NEW WASHINGTON—Clark
STORY—Brown

Indiana-Kentucky

JEFFERSONVILLE[1]—Clark

Kansas

ANDOVER[1]—Butler
BUCYRUS—Miami
DERBY[1]—Sedgwick
MAIZE[1]—Sedgwick
OCHELTREE—Johnson
VALLEY CENTER[1]—Sedgwick

Kentucky

EDDYVILLE*[2]—Lyon

GOLDEN POND*[2]—Trigg
PROVIDENCE*[2]—Webster

Kentucky-Tennessee
NEW CONCORD*[2]—Calloway
WATER VALLEY*[2]—Graves

Louisiana
BRIMSTONE—Calcasieu
BUHLER—Calcasieu
DE QUINCY—Calcasieu
GAYTINE—Beauregard
GORDON—Beauregard
HECKER—Calcasieu
SICILY ISLAND*—Catahoula

Maine
BUCKSPORT*[1]—Hancock

Maryland
BALTIMORE EAST[1]—Baltimore
BEL AIR—Harford

Maryland-Pennsylvania
DELTA—York
FAWN GROVE—York

Massachusetts—New Hampshire
HAVERHILL—Essex

Michigan
BESSEMER—Gogebic
SAGOLA—Dickinson

Michigan-Wisconsin
IRON MOUNTAIN—Dickinson
NORWAY—Dickinson
NORWAY*—Dickinson

Minnesota
ISABELLA*—Lake
TOFTE*—Cook

Minnesota-Wisconsin
RUSH CITY*—Chisago

Missouri
ALDRICH—Polk
ASH GROVE—Greene
BEAR CREEK—Cedar
BONA—Dade
BRANSON—Taney
CEDARVILLE—Dade
CRISP—Dade
FAIR PLAY—Polk
FORSYTH—Taney
GREENFIELD—Dade
HIGHLANDVILLE—Christian
KINGS POINT—Dade
LOCKWOOD—Dade
SOUTH GREENFIELD—Dade
SPOKANE—Christian
WAGONER—Cedar
WALNUT GROVE—Greene

Montana
ABSAROKEE—Stillwater
ANTELOPE POINT—Stillwater
COW FACE HILL—Stillwater
GREYCLIFF—Sweet Grass
OTTER CREEK SCHOOL—Sweet Grass
REED POINT—Stillwater
RUSSELL GULCH—Sweet Grass
RYAN CREEK—Sweet Grass
WHITEBIRD SCHOOL—Stillwater

Nevada
GLENBROOK—Douglas
HAWTHORNE*—Mineral
MARLETTE LAKE—Washoe

New Jersey
BARNEGAT LIGHT—Ocean
STANHOPE[1]—Sussex
STONE HARBOR—Cape May

New Jersey-Pennsylvania
BELVIDERE[1]—Warren

New Mexico
ANTELOPE SINK—Eddy
BERNALILLO*[2]—Sandoval

New York
BAY SHORE EAST—Suffolk
BOONVILLE[1]—Oneida
CAMILLUS—Onondaga
CASSADAGA—Chautauqua
CLINTON[1]—Oneida
COLDEN—Erie
FLORENCE[1]—Oneida
LYSANDER—Onondaga
MARCELLUS[1]—Onondaga
NORTH WESTERN[1]—Oneida
ROME[1]—Oneida
SAINT JAMES—Suffolk
SCHENECTADY—Schenectady
SHINNECOCK INLET—Suffolk
SKANEATELES—Onondoga
SPAFFORD[1]—Onondaga
THIELLS—Rockland
UNION SPRINGS—Cayuga
WEST LEYDEN[1]—Lewis

New York-Connecticut
MILLERTON—Dutchess
PLUM ISLAND—Suffolk

North Carolina
ACME*—Columbus
ANSONVILLE—Anson
CRESWELL SE—Washington
ELLERBE—Richmond
HARRISVILLE—Montgomery
LILESVILLE—Anson
MANGUM—Richmond
MOUNT GILEAD EAST—Montgomery
NEW LAKE—Hyde
NEW LAKE NW—Hyde
PLYMOUTH EAST—Washington
PUNGO LAKE—Washington
ROCKINGHAM—Richmond
ROPER NORTH—Washington
ROPER SOUTH—Washington
WADESBORO—Anson

Ohio
SOUTHEAST COLUMBUS—Franklin

Oklahoma
CHOCTAW—Oklahoma
FRANKLIN—Cleveland
HARRAH—Oklahoma
HORSESHOE LAKE—Oklahoma
MIDWEST CITY[1]—Oklahoma
SPENCER[1]—Oklahoma
STELLA—Cleveland

Oregon
BIRKENFELD*—Columbia
COLTON—Clackamas
ENRIGHT*—Tillamook
GRAND RONDE*—Polk
MACE MTN.*—Douglas
MT. McLOUGHLIN*—Jackson
PELICAN BUTTE*—Klamath
SADDLE MOUNTAIN*—Clatsop
SITKUM*—Coos
TIMBER*—Washington
WILHOIT—Clackamas

Oregon-California
SURVEYOR MTN.*—Klamath

Oregon-Washington
CAMAS—Clark

Pennsylvania
COLUMBIA EAST—Lancaster
EPHRATA—Lancaster
HAMBURG—Berks
HONEY BROOK—Chester
KUTZTOWN—Berks
LEOLA—Lancaster
LITITZ—Lancaster
MALVERN—Chester
MANHEIM—Lancaster
NEW RINGGOLD—Schuylkill
NEW TRIPOLI—Schulykill
PHOENIXVILLE—Chester
TEMPLE—Berks
TERRE HILL—Lancaster

South Carolina
HILTON HEAD—Beaufort

Tennessee
ALTAMOUNT—Grundy
BEAVERDAM SPRINGS—Hickman
BURGESS FALLS—White
COBLE—Hickman
COLLINS—Grundy
DRY VALLEY—Putnam
GATLINBURG[1]—Sevier
GORDONSBURG—Lewis
GRAVES SPRING—Perry
GREENFIELD BEND—Maury

Tennessee
HENRY—Henry
HUNTINGDON—Carroll
MONTEREY LAKE—Putnam
MT. JOY—Maury
PLEASANTVILLE—Hickman
PORTLAND—Sumner
RIVERTON—Fentress
SILVER POINT—Putnam
SUNRISE—Hickman
VINE—Wilson

Texas
BELLAIRE[1]—Harris
FAIRY—Hamilton
FORT WORTH—Tarrant
HALTOM CITY—Tarrant
HOUSTON HEIGHTS[1]—Harris
JACINTO CITY[1]—Harris
LAGUNA VISTA[1]—Cameron
PASADENA[1]—Harris
RIVIERA BEACH*[2]—Kleberg
SETTEGAST[1]—Harris
THOMAS RANCH—Randall
WASHBURN—Armstrong

Utah
BRIGHAM CITY—Box Elder
DROMEDARY PEAK—Salt Lake
EUREKA[1]—Juab
GROVER*—Wayne
HATCH ROCK*—San Juan
MILLS JUNCTION—Tooele
‡NOTOM 1 NE—Wayne
‡NOTOM 1 NW—Wayne
‡NOTOM 1 SE—Wayne
STOCKTON*[1]—Tooele
TABLE MOUNTAIN—Tooele
THE WICKIUP*—Emery

Utah-Arizona
OLJETO*—San Juan

Utah-Colorado
LA SAL*—San Juan
POLAR MESA*—Grand

Vermont
POWNAL—Bennington
STAMFORD—Bennington

Virginia
BRANDON—Prince George
CHARLES CITY—Charles City
CLAREMONT—Surry
DENDRON—Surry
PROVIDENCE FORGE—New Kent
ROXBURY—Charles City
SURRY—Surry
WALKERS—New Kent
WESTOVER—Charles City

Washington
BLACK ROCK SPRING NE—Yakima
BLACK ROCK SPRING SW—Yakima
ELEPHANT MOUNTAIN—Yakima
FALSE BAY—San Juan
FRIDAY HARBOR—San Juan
HUMPTULIPS*—Grays Harbor
LA CENTER*—Clark
MACAFEE HILL*—Grays Harbor
POMONA—Yakima

QUINAULT LAKE*—San Juan
RAYMOND*—Pacific
ROCHE HARBOR—Grays Harbor
WALDRON ISLAND—San Juan
YAKIMA EAST—Yakima

Washington-Oregon
VANCOUVER—Clark

West Virginia
MARTINSBURG¹—Berkeley

West Virginia-Maryland
HEDGEVILLE¹—Berkeley

Wisconsin
CAMPBELLSPORT*—Fond du Lac
HORICON*—Dodge
PATZAU*—Douglas

Wisconsin-Michigan
IRONWOOD—Gogebic
STARLAKE*—Vilas

Wisconsin-Minnesota
MERCER*—Iron
ST. CROIX DALLES*—Polk
WAUPUN*—Dodge
WINCHESTER*—Vilas

Wyoming
BULL CAMP PEAK—Albany
COAD MOUNTAIN—Carbon
COAL BANK BASIN—Carbon
ELK MOUNTAIN—Carbon
ELK MOUNTAIN SW—Carbon
GOAT MOUNTAIN—Albany
MEADS—Carbon
OBERG RANCH—Carbon
OVERLAND—Carbon
OVERLAND CROSSING—Carbon
SHEEP ROCK—Albany
WILCOX—Albany

In addition to the standard series of quadrangle maps, small-scale (1:250,000) maps of areas in the United States and Territories are being published and distributed. They may be purchased from the Geological Survey for 50 cents per copy. An index to the series is available on request.

Alaska
KODIAK

Indiana-Illinois
INDIANAPOLIS

Ohio-Indiana-Kentucky
CINCINNATI

Special metropolitan-area and vicinity maps of major United States cities are being published and distributed by the Geological Survey. These maps are prepared from standard 7½-minute maps at the scale of 1:24,000. Vicinity maps may be purchased from the Geological Survey for the prices indicated below.

AUSTIN AND VICINITY (27 by 37 inches) $1.00.
DAVENPORT, ROCK ISLAND, MOLINE AND VICINITY (39 by 46 inches) $1.50.
GARY AND VICINITY (45 by 60 inches) $1.50.
PEORIA AND VICINITY (30 by 39 inches) $1.00.
PIKES PEAK AND VICINITY (32 by 32 inches) $0.75. This map is at the scale of 1:62,500.

Lake Survey Charts

PUBLICATION of new editions of the following Lake Survey Charts has been announced by the United States Lake Survey of the Corps of Engineers, U. S. Army. Copies of these charts may be obtained from the U. S. Lake Survey, 630 Federal Building, Detroit 26, Mich., at 75 cents per copy. Payment is required in advance by P. O. money order or draft, payable to the Treasurer of the United States. A catalog showing the areas described below is available free upon request.

3.—Lake Erie. General chart of the entire lake at 1:400,000 scale. (April 1957)
42.—Lake St. Clair. Entire lake including St. Clair River to Woodtick Island at 1:60,000 scale. (February 1957)
70.—North end of Lake Michigan, north of Arcadia, Mich., and Kewaunee, Wis., at 1:240,000 scale. (March 1957)
73.—Coast Chart. Algoma, Wis., to 18 miles south of Sheboygan, Wis., at 1:120,000 scale. Insets: Kewaunee, Wis., and Two Rivers, Wis., at 1:10,000 scale. (February 1957)
74.—Coast Chart. 10 miles north of Port Washington, Wis., to Waukegan, Ill., at 1:120,000 scale. Insets: Port Washington, Wis., Kenosha, Wis., and Waukegan, Ill., at 1:10,000 scale. (March 1957)
75.—Coast Chart. South end of Lake Michigan from Waukegan, Ill., to South Haven, Mich., at 1:120,000 scale. Inset: Michigan City., Ind., at 1:10,000 scale. (March 1957)
703.—Coast Chart. Green Bay south of Peshtigo Point and Horseshoe Point, Wis., including Sturgeon Bay Canal and coast from Jacksonport, Wis., to Kewaunee, Wis., at 1:80,000 scale. Insets: Oconto, Wis., at 1:20,000 scale. Algoma, Wis., at 1:10,000 scale. (March 1957)
705.—Coast Chart. Platte Bay, Mich., to Lake Leelanau, Mich., including the Manitou and Fox Islands. Insets: Leland, Mich., at 1:2,500 scale. South Manitou Harbor, Mich., at 1:30,000 scale. (January 1957)
726.—Lake Winnebago, Wis., at 1:60,000 scale. Fox River, Wis., from Lake Winnebago to De Pere, Wis., at 1:30,000 scale. (January 1957)
751.—Chicago Lake Front, from Wilmette, Ill., to Gary, Ind., and Chicago Sanitary and Ship Canal to Lockport, Ill., at 1:60,000 scale. Inset: Gary Harbor, Ind., at 1:15,000 scale. (March 1957)
755.—Calumet Harbor, Ill., Indiana Harbor, Ind., Buffington Harbor, Ind., and Calumet Lake at 1:15,000 scale. (March 1957)

1957 Great Lakes Pilot including the complete set of seven monthly Supplements (May through November). $3.00

Tidal Current Charts of New York Harbor have recently been issued by the Coast and Geodetic Survey. The 12 charts of this series are published in one folder, Serial No. 551, which may be purchased from the Coast and Geodetic Survey or chart agencies located in principal ports at 50 cents per copy.

Public Land Survey Plats

THE FOLLOWING plats of public land surveys and resurveys were completed and accepted by the Bureau of Land Management between March 1 and May 31, 1957. The class or purpose of the survey is indicated. Copies of plats may be secured from the Bureau offices in the States or from the Director, Bureau of Land Management, Department of the Interior, Washington 25, D. C.

Alaska
U. S. Survey No. 2754 B, Townsite of Tanana
U. S. Survey No. 3390, Clear Lake Homesite Group
U. S. Survey No. 3408, Island Surveys
U. S. Survey No. 3452 A and B, Townsite of Teller

Alaska—Seward Meridian
T. 11 N., R. 2 W.—Survey–part
T. 16 N., R. 3 W.—Survey–part

Colorado—Sixth Principal Meridian
T. 2 N., R. 70 W.—Tract Survey–Bureau of Standards
T. 3 N., R. 76 W.—Dependent Resurvey and Subdivisional Survey–Section 22
T. 1 S., R. 70 W.—Tract Survey–Bureau of Standards
T. 3 S., R. 74 W.—Extension Survey
T. 10 S., R. 84 W.—Survey–Aspen Townsite Addition

Florida—Tallahassee Meridian
T. 7 S., R. 15 E.—Extension Survey–Sections 5 and 6
T. 19 S., R. 16 E.—Extension Survey–Section 25

Idaho—Boise Meridian
T. 14 S., R. 14 E.—Dependent Resurvey–All
T. 15 S., R. 14 E.—Dependent Resurvey–Part
T. 16 S., R. 14 E.—Dependent Resurvey–Part
T. 7 S., R. 24 E.—(2) Supplemental Survey
T. 7 S., R. 25 E.—(2) Supplemental Survey
T. 9 S., R. 25 E.—Dependent Resurvey–Part

Louisiana—Louisiana Meridian
T. 15 S., Rs. 12 and 13 E.—Island Survey

Minnesota—Fifth Principal Meridian
T. 139 N., Rs. 26 and 27 W.—Island Survey
T. 110 N., Rs. 28 and 29 W.—Island Survey

Montana—Principal Meridian
T. 16 N., R. 20 E.—Small Tract Survey
T. 8 S., R. 23 E.—Dependent Resurvey
T. 8 S., R. 24 E.—Dependent Resurvey
T. 9 S., R. 25 E.—Dependent Resurvey

Nevada—Mt. Diablo Meridian
T. 19 N., R. 20 E.—Dependent Resurvey and Subdivisional Survey–Section 34
T. 31 N., R. 24 E.—Investigative Survey
T. 32 N., R. 24 E.—Investigative Survey
T. 8 N., R. 44 E.—Survey–All
T. 19 N., R. 55 E.—Dependent Resurvey and Extension Survey
T. 20 N., R. 55 E.—Dependent Resurvey and Extension Survey
T. 21 N., R. 55 E.—Dependent Resurvey and Extension Survey
T. 22 N., R. 55 E.—Dependent Resurvey and Extension Survey
T. 23 N., R. 55 E.—Dependent Resurvey–Part
T. 8 S., R. 62 E.—Survey of Exteriors
T. 8 S., R. 63 E.—Survey of Exteriors
T. 8 S., R. 64 E.—Survey of Exteriors
T. 8 S., R. 65 E.—Survey of Exteriors
T. 8 S., R. 66 E.—Survey of Exteriors

New Mexico—New Mexico Principal Meridian
T. 3 N., R. 1 W.—Dependent Resurvey
T. 3 N., R. 2 W.—Dependent Resurvey
T. 6 N., R. 2 W.—Dependent Resurvey
T. 6 N., R. 6 W.—Dependent Resurvey
T. 31 N., R. 8 W.—Dependent Resurvey

Oregon—Willamette Meridian
T. 37 S., R. 1 E.—Dependent Resurvey–Section 23

South Dakota—Fifth Principal Meridian
T. 114 N., R. 62 W.—Dependent Resurvey
T. 116 N., R. 64 W.—Dependent Resurvey

Utah—Salt Lake Meridian
T. 27 S., R. 13 E.—Skeleton Survey
T. 28 S., R. 13 E.—Skeleton Survey
T. 29 S., R. 13 E.—Skeleton Survey
T. 28 S., R. 14 E.—Skeleton Survey

Wisconsin—Fourth Principal Meridian
T. 43 N., R. 5 E.—Omitted Land Survey
T. 38 N., R. 9 E.—Omitted Land Survey

Wyoming—Sixth Principal Meridian
T. 40 N., R. 75 W.—Dependent Resurvey
T. 41 N., R. 75 W.—Dependent Resurvey
T. 42 N., R. 75 W.—Dependent Resurvey
T. 40 N., R. 76 W.—Dependent Resurvey
T. 40 N., R. 77 W.—Dependent Resurvey
T. 55 N., R. 100 W.—Supplemental Survey–Sections 8 and 9

Precision Instruments, Inc.

A new corporation, Precision Instruments, Inc., which will import and distribute surveying instruments of foreign manufacture, has been formed in Troy, N. Y. The firm will handle lines which are noncompetitive with those of current domestic manufacture. Germany, Great Britain, and Japan will be among the sources of equipment.

Optical theodolites manufactured by Cooke, Troughton & Simms, York, England, head the list. The Tavistock theodolite and the V-308 will be available. The Ertel automatic level will be imported from Munich. Path transits and levels from Japan are being imported for surveyors, contractors, and builders. Although built in Japan, they were designed by Americans who have close supervision over their manufacture. The Path line was selected after a careful investigation of many foreign makes by the staff of Precision Instruments.

The President of the new firm is ACSM Past President Lester C. Higbee. Offices are at 1906 Fifth Avenue, Troy, N. Y.

Comment and Discussion

The pages of SURVEYING AND MAPPING are open to a free and temperate discussion of all matters pertaining to the interests of the CONGRESS. It is the purpose of this Department to encourage comments and published material or the presentation of new ideas in an informal way.
—EDITOR

TWO SIDES AND THE INCLUDED ANGLE

LOGAN N. MUIR, JR.*—"The Case of Two Sides and the Included Angle" by Thomas L. Cloonan appearing in the January–March 1957 issue of SURVEYING AND MAPPING presented an interesting approach to the solution of a triangle with known values for two sides and the included angle. Our firm, however, has always preferred a procedure in which inversing is used instead of squaring and square roots. Our procedure follows the pattern of the traverse itself as illustrated on the attached traverse sheet and this has the following advantages: (1) The form of the computation, being the same as the traverse itself, is more readily understood by persons computing routine traverses, (2) large numerals with a questionable number of significant figures, such as result from squaring, are not involved, and (3) square roots are eliminated.

Although it might be said to be a disadvantage that more work has to be written down, at least two advantages are that (1) the work can be checked step by step and (2) the coordinates of all points can be determined if desired.

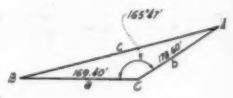
Either of two approaches can be used. If only the length of side *C* is required, then the line *BC* can arbitrarily be given a bearing of East thus eliminating a multiplication process. If the actual coordinates of point *C* are required, then the actual traverse bearings can be carried to *BC* and *CA* for use in the computations.

In either case, simply calculate a traverse from *B* to *C* to *A* and inverse back to *B*. The attached traverse sheet uses the same example given by Mr. Cloonan for puproses of comparison. Note that identical calculations are involved up to a certain point.

Because the process of inversing is so commonplace among surveyors and computers, it is not deemed necessary to describe the computations here.

* Packard, Muir & Train, Inc., 3260 Jay St., Sacramento 16, Calif.

PACKARD, MUIR & TRAIN, Inc.
3260 JAY STREET • SACRAMENTO 16, CALIFORNIA
GILBERT 1-6977



COMPUTATION OF COORDINATES

WORK ORDER NO. 2000
CLIENT
COMPUTER L.H.M.
PAGE OF
DATE 6-27-57

STATION	~~AZIMUTH~~ BEARING	DISTANCE	COSINE	SINE	LATITUDE FEET Y	DEPARTURE FEET X	COORDINATE Y-FEET	COORDINATE X-FEET
B							000.00	000.00
C	EAST (Assumed)	169.40'	0	1	0	+ 169.40	000.00	+ 169.40
A	N. 75°47' E.	178.60'	.2455804	.9693740	+ 43.86	+ 173.13	+ 43.86	+ 342.53
INVERSE	T = 6 = 7.800621							
B	S. 82°42'11" W.	345.33	.1270117	.9919012	- 43.86	- 342.53	000.00	000.00

L. V. JEWELL*—I have read with interest Mr. Cloonan's article in the January–March issue.

Like so many so-called shortcuts, this method is really an application of the coordinate system as found in all surveying texts. He uses a "local" system in which the origin is at point B, and in which the X axis lies along the line BC. This eliminates computation of the coordinates for the point C, and somewhat simplifies the computation of point A's coordinates. The length of line AB may be stated in the conventional nomenclature as:

$$AB = \sqrt{(X_A - X_B)^2 + (Y_A - Y_B)^2},$$

or as Mr. Cloonan gives in his last equation on page 67:

$$AB = \sqrt{OA^2 + OB^2}.$$

(There is a typographical error in this equation as printed in the magazine.)

If the premise given in his second paragraph is used, the direction of this line is already known, as A and B are intervisible. If they are not intervisible, then the direction of line AB with respect to BC is:

$$\tan^{-1}\frac{OA}{OB}.$$

I was intrigued by Mr. Cloonan's reference to extracting square roots with the calculating machine, and wondered what system he uses. I have tried a number of ways, and finally decided that a convergence method, which was explained to me a short time ago, was the best for the type of machine I use.

Suppose we try the example cited in the article:

$$342.53^2 + 43.86^2 = 119{,}250.5005.$$

Now *guess* a value for the square root. (A table of squares enables you to make an extremely educated guess.) We know that it will be somewhat more than 342, so let's guess 350. Divide this figure into the square:

$$\frac{119{,}250.5005}{350} = 340.72.$$

Take the arithmetic mean of 340.72 and 350.00 mentally:

$$\frac{340.72 + 350.00}{2} = 345.36.$$

Square 345.36 on the machine. The result is 119,273.5296. Comparison with the original square shows this square to be 23 too high. Since we want our square root to be accurate to the hundredth of a foot, the difference between the original square and the square of the final trial can not be more than 2 per cent of the square root. (Approximately.) In our problem, the difference should not be more than 7, so we must try again.

Repeat, using 345.36 as a trial divisor:

$$\frac{119{,}250.5005}{345.36} = 345.29.$$

The mean this time is:

$$\frac{345.36 + 345.29}{2} = 345.325.$$

Squaring 345.325, we get 119,249.3556. Since this new square differs from the original square by only 1.2, we know that it [the square root] is accurate at least to the hundredth of a foot.

The convergence is rapid, and more than two trials are seldom required. Like most machine operations, the explanation takes much more time than the performance. I have tried other methods, such as subtracting consecutive odd numbers, and using tables of divisors furnished by machine manufacturers, but I believe this method is superior.

* Asst. Div. Engineer, The Detroit Edison Company, 2000 Second Ave., Detroit 26, Mich.

TRIVIA

SAMUEL YATES*—Mr. Hunter's clever solution of the problem of devising a formula for the array of sections in a township shows commendable ingenuity.**

Using his careful analysis of the problem as a basis, I have arrived at a completely different formula which will give the same results without the use of variable exponents. Here it is:

$$N = 6r + 1 - c + (2c - 7)\cos^2 r\pi/2$$

* 2159 Tyson Avenue, Philadelphia, Pa.

** *See* SURVEYING AND MAPPING, April-June 1957, Vol. XVII, No. 2, pages 183–184.

News of Related Organizations

Kansas Society of Land Surveyors

The Kansas Society of Land Surveyors was organized at a meeting held at 7:30 p.m., April 30, 1957, in the City Hall at Salinas, Kans.

Paul H. Sweeney was elected temporary chairman. Wendell C. Wyatt* was elected secretary-treasurer.

Paul H. Sweeney, Harold Harper, and Wendell C. Wyatt* were named to form a committee on the drafting of a constitution and a set of bylaws.

Regular meetings are scheduled to be held on the last Tuesday of each month. The meeting of June 25, 1957, was devoted to a review of the proposed constitution and matters pertaining to several State Bills which failed in the 1957 Senate Session.

* Member of ACSM.

GARLS Elect New Officers

New officers of the Georgia Association of Registered Land Surveyors for the 1957–1958 fiscal year are as follows:

President—Sommers J. Gostin, Partner, Winchester and Gostin, Macon, Ga.

Vice President—J. Harold Smith, County Surveyor, Upson County, Ga., private practice with J. Burruss Smith, Thomaston, Ga.

Secretary–Treasurer—C. T. Holladay, Head, Civil Engineering Department, Southern Technical Institute, Chamblee, Ga.

Directors—for the two-year period 1957–1959 are:

R. M. Marbury, Sr., Albany
S. R. Fields, Lawrenceville
J. O. Eichler, Atlanta
George E. Warren, Sylvester
E. L. Boggus, Atlanta

Because of the change in Secretary-Treasurer, the Association has acquired a new mailing address. Hereafter, mail should be sent to Secretary-Treasurer Holladay at 1560 N. Fearn Ct., N.E., Atlanta, Ga.

A Belated Recognition

In the rush and resulting confusion of getting the material regarding the 1957 Annual Meeting assembled and prepared for publication, a rather important item was overlooked: the following resolution of appreciation for efforts in preparing for and staging the 1957 Annual Meeting. My apologies for the delay in the publication of this resolution, which was passed by the Board of Direction on March 8, 1957. —EDITOR

The American Congress on Surveying and Mapping expresses its sincere appreciation to all committee workers and participants for their splendid and successful efforts in presenting the 1957 Annual Meetings. Thanks go also to all those behind the scenes, the exhibitors, the hotel staff, the officers and members of both ACSM and ASP, and in particular to the Meetings Chairmen, Franklin G. Williams for ACSM, and J. W. Halbrook for ASP, for a job well done, and without whose spirit in support the show could not have gone on.

CONGRESS NEWS

Colorado Section

The Colorado Section of the American Congress on Surveying and Mapping met at the Schmitt Elementary School Auditorium, 1820 South Vallejo Street, Denver, Colo., on December 20, 1956. There were twenty-two members and guests present. Professor Thomas A. Kelly, Chairman, presided.

The minutes of the meeting of June 21, 1956, were read and approved.

The ballots for the election of officers for 1957 were tabulated, with Stanley M. Borrell and George Perham acting as tellers. Of the 84 ballots mailed to members in good standing, 44 were returned. The officers elected for 1957 are as follows:

Chairman—Melvin A. Harmel
Vice Chairman—Thomas V. Cummins
Secretary-Treasurer—Mark L. Hickman
Editor—Emmett J. Coon

Stanley M. Borrell reported briefly on the financial results of the ACSM-ASP convention held in Denver last fall and then presented Chairman Kelly with a check in the amount of $283.74, the Colorado Section's share realized from the convention after payment of bills. The members applauded Mr. Borrell for the success of the convention which was brought about under his leadership.

George M. Perham, Secretary-Treasurer, presented the financial statement for the year and this was approved.

Chairman Kelly had made careful preparations for an open forum discussion of the proposed Model Surveyor Registration Act which had been furnished us by the Washington office. One hundred copies of the subject matter had been mailed out to members prior to the meeting, and another 120 copies had been mailed to registered land surveyors in Denver and vicinity, with an invitation for all to attend this meeting. Professor Kelly also had a wire recorder at hand for recording the discussion.

Each person present had a copy of the Model Registration Act in hand, and several practicing land surveyors were present. When the forum was opened it soon developed that there were several items in the Model Act that conflicted with practices in the Denver region, and many of those present were doubtful if such a radical change could be brought about by either local or national legislation.

The discussion brought out the fact that the current practice of competitive bidding on surveying work is making surveyors very cost conscious and that in many cases the accuracy of the surveys is suffering.

The surveyors also indicated that the title guarantee companies exercise more control over land surveying than is apparent on the surface. When errors are found in previous surveys covered by title insurance it is very difficult to get legal recognition of the error.

The State grid system of surveying land and recording titles was discussed, but the surveyors present did not believe that this was the answer to all the problems. There was general agreement that better and more uniform registration laws are badly needed, but no firm agreement was reached as to what that law should be.

The meeting of May 7, 1957, was held at the Lakewood American Legion Club, 1655 Simms Street, Lakewood, Colo., with Chairman Melvin A. Harmel presiding and twenty members and guests present.

After the minutes of the meeting of December 20, 1956, had been read and approved, Past Chairman Thomas A. Kelly gave a general report of his attendance at the ACSM-ASP Convention in Washington, D. C.

In general, he reported that he was disappointed in the over-all technical sessions of the convention. From his standpoint the convention would have been much more fruitful if there had been more sessions of committees discussing and arriving at definite decisions on specific problems rather than the presentation of so many formal papers, many of which were read by persons other than the authors.

He reported that the most interesting session was the report on the Tellurometer. He gave us some information on the accuracies in measurement that had been attained by the instrument and explained the basic theory on which the instrument operates. He believes that this instrument may revolutionize geodetic practices.

Chairman Harmel informed the group that he intends to appoint committees on Education, Legislation and Registration soon.

He then introduced Mr. Hagerty of the Title Guarantee Insurance Company of Denver. Mr. Hagerty had been invited to speak to the group because of the questions brought up at the December meeting regarding the indirect control over land surveyors exercised by title insurance companies.

He explained the role of the title insurance companies in relation to the loan companies, the building contractors, and the home buyers. He pointed out that their work concerns legal description and the examination of titles rather than the determination as to whether or not a particular survey is correct. After his talk the meeting was opened for questions. This resulted in a lively discussion of what protection to the buyer is provided by title insurance.

Mr. Hagerty brought out the fact that title insurance does not guarantee to the buyer that the survey of his property as marked on the ground is correct, but only that the property description in the deed is correct. It is the responsibility of the buyer to have his improvements on or within the property lot lines. Title insurance is for the protection of loans rather than for the protection of buyers.

The writer concludes that title insurance companies are not concerned with the accuracy of surveys until a conflict arises that involves the changing of a legal description. Then they are quite firm in maintaining the status quo until legal action brings about a change in the land description.

Chairman Harmel announced the joint ACSM-ASP dinner meeting to be held May 22, 1957, after which the meeting was adjourned.

—EMMETT J. COON
Editor

Louisiana Section

The Louisiana Section of the American Congress on Surveying and Mapping assembled for the annual dinner meeting on May 6, 1957, in the Engineers Club, De Soto Hotel, New Orleans, La.

Members and visitors gathered for an informal cocktail hour at 6:00 p.m., with dinner being served at 7:15 p.m., to a total of 83 persons.

Chairman Martin Standard called the meeting to order at 8:40 p.m., and presented S. P. Chapman, Program Chairman, who introduced the guest speaker of the evening—Robert H. Lyddan, Assistant Director of the U. S. Geological Survey and President of the American Congress on Surveying and Mapping. Mr. Lyddan spoke on the subject "Mapping in the Geological Survey, Past and Present." He discussed early maps and charts and the improvements and new methods employed in the construction of the modern topographic map.

Chairman Standard then announced and introduced the following newly elected officers and directors:

Chairman—G. E. Jones
First Vice Chairman—C. E. Bridges
Second Vice Chairman—G. E. Mott

Left to right: G. W. Herzog, a former Director, ACSM; George Jones, Chairman, Louisiana Section, ACSM; Robert H. Lyddan, President, ACSM; Martin Standard, Past Chairman, Louisiana Section, ACSM; and S. P. Chapman, Director, ACSM.

Third Vice Chairman—C. T. Armstrong
Secretary—R. C. Dayton
Treasurer—H. G. Snead
Directors (1957–1959)—
Commander Ross A. Gilmore
Roy T. Sessums
Carl E. Heck

George Jones, newly elected Chairman, expressed his appreciation for the opportunity to serve as Chairman and for the fine group of officers elected to serve with him.

The meeting was brought to a close at 10:00 p.m.

—Robert Baker, Jr.
Section Editor

Personals

Rear Admiral **H. Arnold Karo,** Director, Coast and Geodetic Survey, Washington, D. C., has been elected President of the Society of American Military Engineers.

Captain **George A. Nelson** retired from the Coast and Geodetic Survey on July 1, 1957, after serving with that organization from August 10, 1925 to the date of his retirement.

Captain **Ralph L. Pfau** retired from the Coast and Geodetic Survey on April 1, 1957, after serving approximately 33 years with that organization. At the time of his retirement he was Assistant Chief, Division of Geodesy.

Jon S. Beazley, ACSM Advisory Council member from Florida, is Engineer of Photogrammetry for the Photogrammetric Division of the State Roads Department of Florida, at Tallahassee.

Aubrey H. DaSantos was recently appointed Manager of the Branch Plant of **Jack Ammann,** Photogrammetric Engineers, Inc., in Atlanta, Ga.

Lew Suverkrop, Bakersfield, Calif., has sold the patents on his "educated" plumb bob to the Charles Brunning Co.

Grady S. Harrell, Shannon, N. C., has received a Citation of Award from the Professional Engineers of North Carolina for "his continuous, dedicated and devoted effort as a member of the North Carolina Board of Registration for Professional Engineers and Land Surveyors."

Calvin S. Maltby has been appointed Chairman of the Program Committee for the 1958 Annual Meeting of the American Congress on Surveying and Mapping.

Prof. **Russell C. Brinker,** formerly head of the Civil Engineering Department, Virginia Polytechnic Institute, Blacksburg, Va., has resigned from that position to become Editor of Engineering Publications with the Ronald Press in New York City.

Kenneth E. Reynolds has been named to head a new Contract and Defense Products Division of the Bausch & Lomb Optical Company. Mr. Reynolds, who has been with that company since 1937, is also president of the American Society of Photogrammetry.

Robert E. Frederick announces the establishment of the land surveying and construction engineering firm of R. E. Frederick & Associates, with offices at 202 N. State Road, Arlington Heights, Ill.

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Obituary

Joseph Ambrose Smith, of 126 Camberwell Drive, Fairview Heights, Pittsburgh, Pa., passed away on July 14, 1957, at the age of 58 years. Burial was in the family plot at Ligonier, Pa. He is survived by his widow, who resides at the Camberwell Drive address.

In informing the editor concerning the death of Mr. Smith, Mr. **J. Lewis Scott** wrote:

"Joe did not have a degree in civil engineering but he had a keen mind for details and acquired a broad experience in land and construction surveys by working with good engineers all his life. The Pittsburgh Railways kept him busy for the last twelve years surveying boundary lines and street car lines."

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Sea Wave Warning System Ready for Pacific Coast

The Coast and Geodetic Survey has completed arrangements to give warnings of seismic sea waves to civil defense authorities along the Pacific Coast.

New charts, showing the travel times for sea waves originating on the northern rim of the Pacific Ocean, chiefly in the area of the Aleutian Islands, have just been finished. They will be used by technicians in the Survey's magnetic observatory at Honolulu.

When an earthquake occurs in an area likely to create a troublesome wave—say in the ocean floor near the Aleutians—the observatory finds out from its own or cooperating tide stations whether a wave has actually started. Then the observatory notifies the military and civil authorities of the estimated time of arrival.

The system has operated effectively in Hawaii, whose shores are particularly vulnerable. Until the new charts were prepared, it was not possible to give close estimates for other points.

Five charts have been made, giving the time required for seismic sea waves from various points along the northern rim of the Pacific to reach (1) Neah Bay, Wash., at the entrance to Puget Sound; (2) Crescent City, Calif.; (3) San Francisco (Golden Gate); (4) San Diego, and (5) La Jolla.

The director of the Coast and Geodetic Survey has notified the State civil defense offices in Olympia, Salem, and Sacramento that estimated arrival times will be dispatched to them from Honolulu at the time information affecting Hawaii is issued locally.

In the opinion of Survey experts, the northern Pacific Ocean area is the only source of potentially damaging seismic sea waves, with the possible exception of the ocean bottom off the Pacific Coast of the United States. A warning system could not be effective for any waves of such close origin, because they would arrive in a matter of minutes instead of hours.

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The Coast and Geodetic Survey, 1807–1957

As a part of the celebration of its Sesquicentennial Anniversary, the Coast and Geodetic Survey has published an illustrated booklet, "The Coast and Geodetic Survey, 1807–1957." This attractive publication of 96 pages contains a brief history of the accomplishments of the Bureau during the past 150 years.

Written by A. Joseph Wraight and Elliott B. Roberts, this nontechnical account of the work of the Bureau, during the century and a half in which the United States has developed from a fledgling nation to a leader among the world powers, deserves a place in the library of anyone even casually interested in the history of surveying in this country.

The booklet is available from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., for 35 cents per copy.

APPLICATION FOR MEMBERSHIP

I am interested in surveying and mapping and hereby apply for membership in the American Congress on Surveying and Mapping. I enclose $5.00 (U. S. and Possessions), $6.00 (Foreign) in payment of annual dues.

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Applicant's Signature ..... Date .....

(Send to: Chairman, Membership Committee, P. O. Box 6244, Washington 15, D. C.)

Reprints of Articles

Reprints in quantities of 50 or more may be obtained of any article appearing in this issue. Orders must be placed with the Editor-in-Chief, Howard S. Rappleye, 6712 4th St., N.W., Washington 12, D. C., not later than 3 weeks after publication. Authors who wish reprints of their articles may so indicate when manuscripts are submitted. Approximate prices of reprints follow:

	Without Covers						
Number	*4 pp.*	*8 pp.*	*12 pp.*	*16 pp.*	*20 pp.*	*24 pp.*	*Covers**
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Add'l 100s	$ 1.10	$ 1.90	$ 2.90	$ 2.90	$ 4.00	$ 4.90	$ 4.10

* Heavy paper covers—over and above the cost of reprints without covers.

Commemorative Stamp for Surveyors

A drive toward the issuance of a special commemorative stamp or series of stamps for surveyors, which was spearheaded by Stuart J. Boyles, Chairman of the Commemorative Stamp Committee of the Texas Section of ACSM, resulted in the introduction of a Bill (S. 4136) in the 84th Congress. This Bill, introduced by Senator Daniel (now Governor of Texas), was caught in the closing of the 84th Congress. (*See* SURVEYING AND MAPPING, July–September 1956, Vol. XVI, No. 3, page 402.)

Activity looking toward the issuance of a commemorative stamp was given fresh impetus in connection with the Surveyors' Day program held August 23, 1957, at the College of William and Mary in Virginia, as a part of the celebration of the 350th anniversary of the founding of Jamestown.

However, the time was too short to secure the issuance of the commemorative stamp as a part of the Surveyors' Day ceremonies and again the project failed. (*See* SURVEYING AND MAPPING, October–December 1956, Vol. XVI, No. 4, page 531.)

On May 27, 1957, another Bill (S. 2153) was introduced in the 85th Congress by the Senate Majority Leader—the Honorable Lyndon B. Johnson, of Texas. This Bill was referred to the Committee on Post Office and Civil Service but, as of August 2, 1957, had not been scheduled. The Bill is as follows:

A BILL

To authorize the issuance of a special series of stamps as a tribute to the surveyors of the United States.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Postmaster General is authorized and directed to prepare for issuance, on as early a date as practicable, a special series of postage stamps, of such appropriate design and of such denominations as he shall prescribe, as a tribute to the surveyors of the United States for the invaluable services rendered by them in the development of the United States.

Now that the continued activities of the Texas Section of ACSM have resulted in the introduction of S. 2153 in the 85th Congress, all members and Sections of ACSM should lend their support to this project.

Write to your Senator and Representative, asking them to support S. 2153. Also write to the Postmaster General. The philatelic activities of the Post Office Department have been reorganized recently, and a committee to advise on special stamp issues has been created.

Let's get behind those who have worked long and hard to provide for the issuance of the commemorative stamp, or stamps, for surveyors and lend our support. No one individual or one small group has enough strength to push this matter to a successful conclusion, but, if every member of ACSM and the members of related and affiliated organizations all "put their shoulders to the wheel" the combined "push" will certainly be felt.

Write those letters now—before you get busy with something else and neglect to write at all.

Legislation Recognizing Plane Coordinates

Recently, Mr. L. Weems Trussell, Fordyce, Ark., a member of ACSM, sent the Publications Committee a copy of a Bill which had been presented to the General Assembly of the State of Arkansas. It is "An Act to Describe, Define, and Officially adopt a System of Coordinates for Designating the Position of Points on the Surface of the Earth, within the State of Arkansas, and for Other Purposes."

In view of the surveying and mapping operations required for the Interstate Highway Program, the engineers in Arkansas are to be commended for their foresight in presenting this legislation for enactment. There are many other States in which this type of legislation has not been enacted. These States are listed below for the general information of the members of ACSM, with the thought that others may follow the action of Arkansas.

Arizona, Colorado, Florida, Idaho, Illinois, Iowa, Kansas, Kentucky, Michigan, Mississippi, Missouri, Montana, Nebraska, New Hampshire, North Dakota, . Oklahoma, South Carolina, Utah, West Virginia, Wisconsin, and Wyoming.

The Story of Maps

"The Story of Maps," an attractive and colorful teaching aid, has been prepared by General Drafting Company, for Esso Standard Oil Company. The 16-page pamphlet, in picture-book format, traces the history of maps and mapmaking with well-captioned drawings. It also illustrates the various steps in mapmaking, from field and aerial surveys through drafting and reproduction. There is also a page on "how to use your road map" and a glossary of map terms. Teachers may request copies of "The Story of Maps" from Public Relations Department, Esso Standard Oil Company, 15 West 51st Street, New York 19, N. Y., or from any of Esso's division or refinery offices.

—W. W. Ristow

New Maps of Metropolitan Areas

Seventeen new maps of metropolitan areas in 13 States have been published by the Geological Survey in its latest series of topographic maps covering principal cities of the United States. Fourteen others of this series were published in 1955 and 1956.

All maps are at a scale of 1: 24,000 and show all physical and cultural data contained on several 7½-minute topographic maps, including main highways, city streets, and railroad lines; parks, reservoirs, and historic sites; principal public buildings; contour lines; and many locations and landmarks of interest to residents, tourists, and engineering and business firms.

The seventeen latest additions include the following cities: Albuquerque, N. Mex.; Austin, Tex.; Baton Rouge, La.; Buffalo, N. Y.; Davenport, Rock Island, and Moline, Ill.–Iowa; Detroit, Mich. (two sheets); Gary, Ind.; Long Beach, Calif.; Los Angeles, East, and Los Angeles, West, Calif.; Oakland, Calif.; Peoria, Ill.; San Francisco, Calif.; Seattle, Wash.; Toledo, Ohio–Mich.; Wilkes-Barre and Pittston, Pa.; and Worcester, Mass.

Copies are available from the Geological Survey Map Distribution Sections at Washington 25, D. C., for those areas east of the Mississippi River, and at Denver, Colo., for those to the west. These maps are priced at $1.50 each except for Detroit and vicinity which sells for $3 for the set of 2 sheets, and Austin, Tex., and Peoria, Ill., which cost $1 each.

New Format for Sectional Aeronautical Charts

Work has begun on new editions of the 87 Sectional Aeronautical Charts covering the United States. Six of the charts in the new format had been issued by last June.

The most striking change under the new format is the elimination of the blue tint indicating the controlled airspace, which often minimized other important information and altered the gradient tints of the ground elevations. The center of the airways is now indicated by a narrow screened band. The gradient tints also have been changed to colors that produce a more legible portrayal of the terrain. Relief of the land areas is also indicated by contour lines spaced at 1,000-foot intervals instead of 500-foot intervals which was the practice on some of the previous charts.

The charts are designed to provide coverage of the United States at a scale appropriate for moderate speed flights when visual contact with the land surface is desirable. Although intended primarily for contact flying by slow or medium speed aircraft these charts are suitable for limited instrument navigation.

Topographic information includes cities and towns, drainage, principal roads, railroads, distinctive landmarks, and relief. The latter is shown by spot elevations, contours, and gradient tints.

Aeronautical information includes primary radio aids such as omniranges symbolized by a dot within a small circle, which usually has a compass rose centered on the station to facilitate the use of the range, aerodromes, restricted areas, obstructions, and other pertinent data. The runway pattern of each hard surfaced airfield is shown at an exaggerated scale.

The new format was adopted after an extensive experimental period in which a chart of this type was distributed to a cross-section of military, commercial, and private aeronautical chart users. A questionnaire submitted by these users after actual flight tests indicated almost unanimous approval.

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PATH INSTRUMENTOS DO BRASIL, LTDA.

It has been recently announced that a new company, Path Instrumentos do Brasil, Ltda., has been formed, with principal offices in Rio de Janeiro. The assembly plant is being built at Itaipava, about 55 miles outside the city of Rio de Janeiro. "Path of Brazil" will carry a complete line of scientific instruments for South America, including meteorological, surgical, dental, hydrological, and topographical instruments, as well as Path transits and levels.

SPEAKING OF PERMANENT MONUMENTS

A Ripley "Believe It or Not" cartoon, published in the *Washington Post-Herald*, the morning of June 10, 1957, shows a *Milestone*, erected at St. Come, France, by army engineers under Julius Caesar, still standing after more than 2000 years—quite worn and weathered, to be sure, but still standing.

NEW GURLEY LEVEL

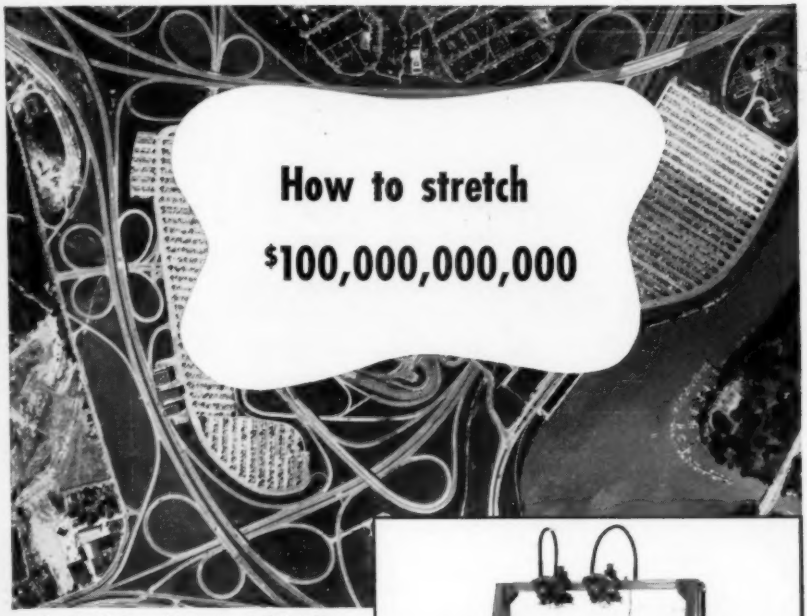
A new Light Dumpy Level—in two models—has been introduced by W. & L. E. Gurley. A low-cost precision instrument, the new instrument is expected to find wide use as a builder's level.

One model, No. 380, is without horizontal circle. The other, No. 380-A, has a circle for reading horizontal angle to five minutes. The level is made largely of high-strength aluminum alloys. The optical system, leveling head, and materials of construction enable it to compare favorably with larger models by the same manufacturer. The telescope is short (13 inches), features the "standout" bubble, hard-coated lenses, and covered glass reticle. Minimum focus is 6½ feet.

AND THEN WHAT?

More years ago than the writer likes to contemplate, he was called upon to "run out" the boundary lines of a farm in the Finger Lakes Region of New York State. The party—two men—arrived bright and early and met the farmer at his house by the road. We had been informed that the two back corners of the farm were marked and that the marks could be recovered easily. We set out for the back line of the farm, and when we were about in the middle of an open pasture of perhaps ten acres in extent the farmer stopped, with what appeared to be an air of finality, and said, "Set up your 'gun' and see if you can see a line around here anywhere."

—EDITOR



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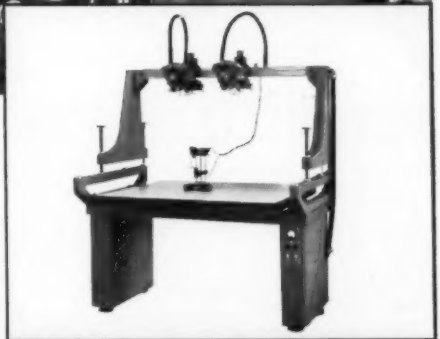

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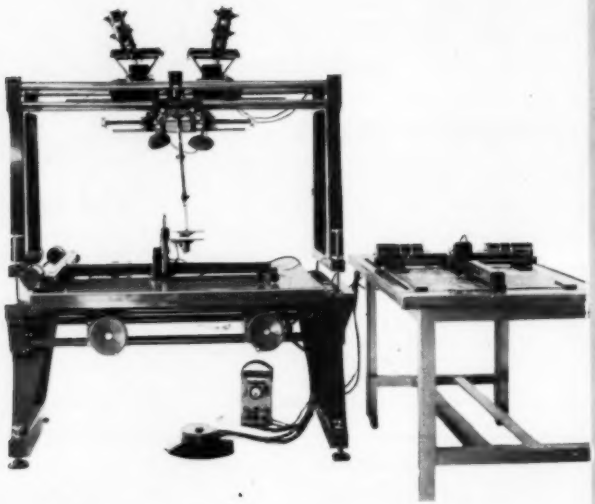

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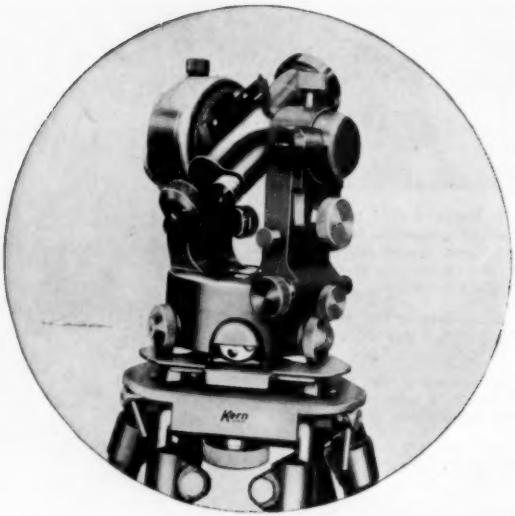

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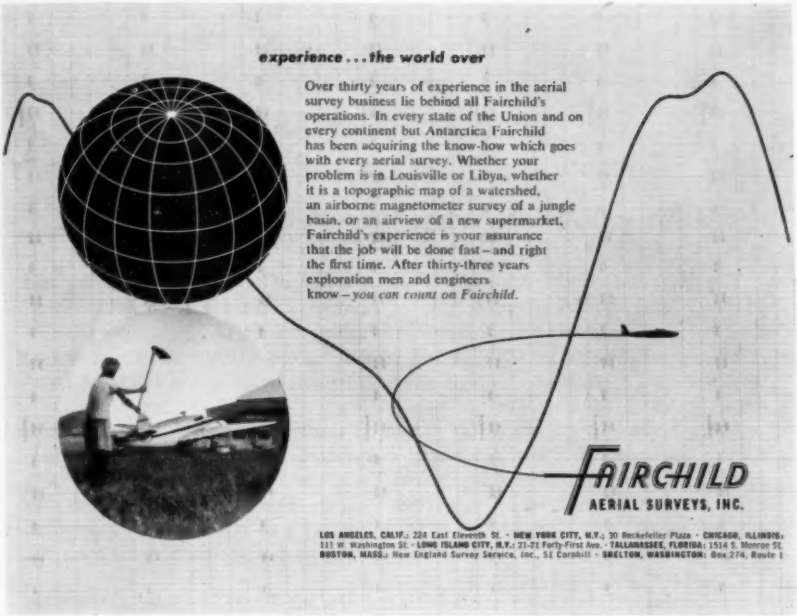
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PRE-CONVENTION JOURNAL

Advertising Tie-in Opportunity

The next Annual Meeting of the American Congress on Surveying and Mapping will be held March 23rd to 26th, 1958.

The October–December issue of the JOURNAL will tie-in with the forthcoming Convention. Prepare to advertise your exhibit and products in this important issue to stimulate the interest of potential buyers attending this event. From an advertising standpoint, this issue will be even more valuable because of the consecutive Annual Meetings of the American Congress on Surveying and Mapping and the American Society of Photogrammetry, March 26th to 29th, 1958.

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1958 ACSM & ASP
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ACSM Eighteenth Annual Meeting—March 23, 24, 25, 26
ASP Twentyfourth Annual Meeting—March 26, 27, 28, 29

The 1958 Consecutive Meetings of the American Congress on Surveying and Mapping and the American Society of Photogrammetry will be held March 23–29, 1958, at the Shoreham Hotel in Washington, D. C.

This convention and co-exhibit will present an opportunity not to be denied to Laymen, Technicians, and Professionals to see, hear, and discuss the latest developments in the fields of Surveying, Mapping, and Photogrammetry.

Many important papers to be presented during the technical sessions will discuss the roles of Instrumentation, Surveying, Mapping, and Photogrammetry in the International Geophysical Year, the Federal Highway Program, and President Eisenhower's Open Skies Policy. There will be continued discussions of subjects covered last year, surveying and engineering equipment, the latest developments in scribing techniques, and up-to-date reports on the Tellurometer tests and experience in its use.

Arrangements have been made with the United States National Committee for the International Geophysical Year to participate in the noncommercial section of our co-exhibits. This display including the much publicised Vanguard Earth Satelite Program, is expected to attract many persons in addition to the technical people attending the convention.

The co-exhibits, which will be located in the new large exhibit hall, offer the largest and best arrangement ever displayed. Some choice exhibit spaces are available. For information, contact Glenn H. Landis, Chairman, Co-Exhibits Committee, 610 Montgomery Street, Alexandria, Virginia.

GLENN C. WELDEN, *Chairman*
1958 ACSM-ASP Publicity Committee

Notice—to ACSM Members and Officers:

Due to ACSM Eighteenth Annual Meeting opening first in the week of the 1958 convention, the ACSM Annual Business Meeting must be scheduled for Tuesday evening. This means that Division and Committee business in preparation for the Annual Business Meeting must be shaped up previously, with many of the Division meetings scheduled for Monday morning. This is a situation similar to that encountered in the 1956 meeting and which is the reverse of that for the 1957 meeting just passed.

Please make your plans and shape your programs accordingly.

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Executive Secretary, ACSM

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